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Subscriptions—In the United States, its possessions, and Mexico, \$5.00 yearly; Canada, \$5.50; elsewhere, \$6.50 the year.

Advertising rates on application. All advertising copy subject to acceptance by publication committee.

Published monthly at Chicago, Illinois, by American Congress of Physical Therapy.

Entered as Second Class Matter June 2, 1930, at the Post Office at Chicago, Illinois, under the Act of March 3, 1879.

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Suite 716 — 30 North Michigan Avenue, Chicago, Illinois

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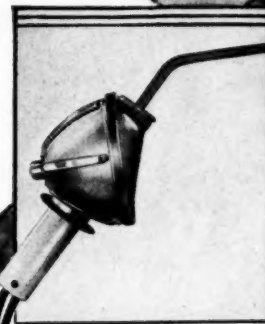
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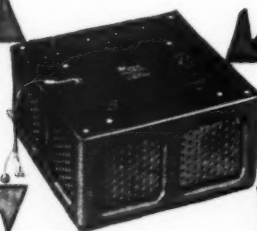
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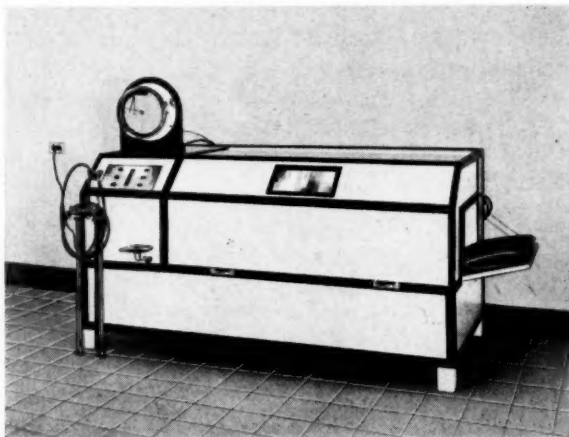
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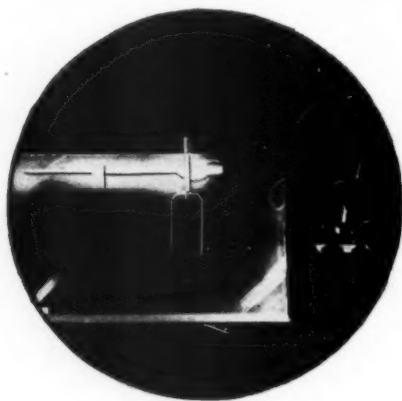
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RADIOTHERMY *

(Fever Induced by Short Radio Waves)

WILLIAM BIERMAN, M.D.

NEW YORK CITY

We have come to realize more definitely that fever is a protective mechanism of the body used against inimical forces. In the past, astute clinicians have recognized its beneficial value (Welch, 1888). Hyperpyrexia has been produced in various ways. Treatment by means of relapsing fever has been utilized (Plaut, 1920), as well as rat-bite fever (Solomon, 1920), and the injection of non-specific proteins (Kundle, 1927). The malarial plasmodia have been injected for the treatment of general paralysis (Wagner von Juaregg, 1918). Sulphur injections have also been used (Schroeder, 1927).

The use of physical measures for the production of hyperthermia has been employed by the ancients many hundreds of years ago. The Egyptians, Greeks and Romans placed great emphasis upon the therapeutic value of hot baths. Such baths have been recently employed in the treatment of neurosyphilis (Mehrtens, 1929).

Diathermy widely employed for local heating, has recently been applied for the development of systemic hyperpyrexia (King, 1930), (Neyman, 1931). The diathermy machines employed for this purpose are more powerful than those ordinarily used. Metal plates as large as can be conveniently fashioned are applied to the torso, anteriorly and posteriorly. These are held in firm contact with the skin (a binder is a useful device for this purpose). The patient is well covered with blankets.

Of the various methods available for the development of hyperpyrexia the one which appears to be the most effective is radiothermy. Radiothermy is the name which the writer has thought descriptive of this particular process of heating substances by means of the Hertzian wave as used in radio transmission.

The temperature of inanimate as well as animate objects may be elevated by means

of these waves (Hosmer, 1928). The machine which we have utilized for the production of hyperthermia is one which produces oscillations of about 10,000,000 cycles per second, corresponding to a wave length of 30 meters. We are indebted to Dr. Willis R. Whitney, Director of Research of the General Electric Company, for placing one of these machines at our disposal.

Regulation of Treatment

The technic for the systemic elevation of temperature in the human subject by means of the high frequency electric field in the radiotherm has been described (Carpenter, 1930). The method consists essentially in placing the subject between the plates of a large condenser which forms part of an oscillating circuit. The oscillations in this circuit are produced by the use of radio tubes of appropriate construction (500 watt screen grid in push pull) with the necessary associated equipment for the attainment of a high frequency electric field of high intensity. The condenser plates between which the subject is placed are large enough (50x80 cm.) to produce a field over a reasonable part of the volume of the subject, and are separated from one another by a distance of approximately one meter. The subject rests upon a canvas stretcher between these plates, but not in contact with them. To prevent loss of heat the entire body with the exception of the head is covered by means of a hood. The air inside of this hood is heated by means of a hot air blower placed at one end. By this mechanism with a total DC plate current of 0.5 amperes and using two UV861 tubes it is possible to produce a body elevation of temperature of about 4° C. in a period of time varying from 40 to 90 minutes.

After the temperature of the patient has been raised to the desired height, he is removed to a bed covered by means of a hood heated by carbon filament lamps. It appears

* Received for publication May 28, 1932.

* Read before the New York Physical Therapy Society, April 6, 1932.

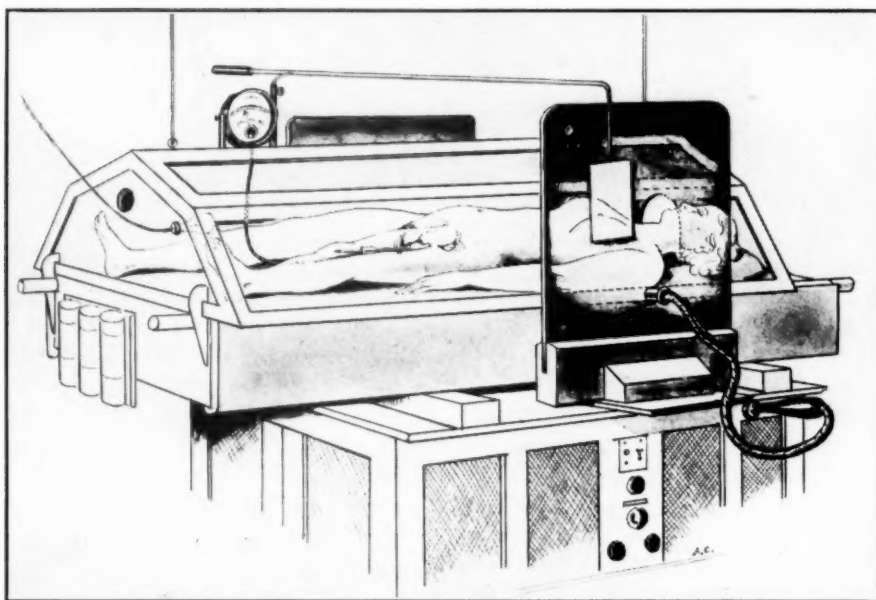


Fig. 1. Illustrates the application of radiothermy with the special localizing technique for the elevation of pelvic temperatures. You will note the pick-up plate on the outside of one of the condenser plates connected to the milliammeter which in turn is connected to the vaginal electrode.

that relatively little external heat is sufficient to maintain and to raise the systemic temperature which has already been elevated.

The patient's temperature is taken at intervals of ten or fifteen minutes by means of a clinical mercury thermometer. These observations are made on the patient while in the machine with the current turned off. For the purpose of keeping close watch of the rectal temperature we have made use of an automatically registering and recording platinum resistance thermometer. This continuously indicates the patient's rectal temperature. We have found that the accuracy of this device is influenced by the oscillations of the radiotherm machine in spite of the use of choke coils and condensers. It is, therefore, only of value in the constant observation of the patient's temperature after he has been removed from the radiotherm.

The pulse rate is determined in the region of the temporal artery inasmuch as the head is outside of the hood. For the automatic registering and recording of the pulse rate our physicist, Mr. Schwarzschild, has made use of a recording millivolt meter and more recently the electrocardiophone, an instrument which translates the electric discharge of the heart into sound.

To observe the respiratory rate of the pa-

tient while in the radiotherm we have utilized a slender wooden rod, the lower end of which is placed on the chest of the patient and the upper end protrudes through a hole in the hood. This rod moves up and down with the respiratory excursions. In the heated bed to which the patient is subsequently removed the respiratory rate is observed through a wired glass window in the hood. Another narrow glass window permits of the reading of the thermometer registering the temperature inside of the hood.

In order to raise the temperature of a localized area of the body beyond that of the systemically elevated temperature we have developed a device which permits us to apply additional electrical energy in that localized area (Bierman, 1932). We have adopted this technic because of the difficulty in raising local temperatures without coincidentally moderating the influence of the heat dispersing mechanism which the normal body possesses. We have utilized this technic particularly for the treatment of pelvic inflammatory disease. With the subject in place between the condenser plates of the radiotherm, an electrode is placed in the vagina. This electrode is connected, through an ammeter, to a small auxiliary metal plate suspended near one of the large condenser plates of the radiotherm. Under

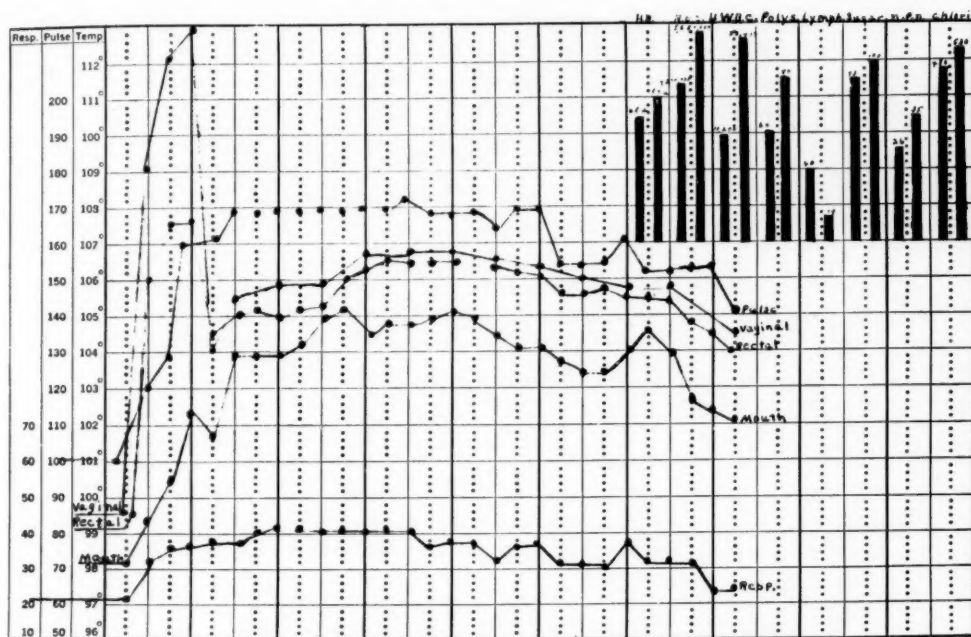


Fig. 2. Illustrates the graphs of the pulse rate, vaginal, rectal and mouth temperatures, and the respiratory rate, where the combined general and special localizing technique was employed. The space between the heavy lines indicates a time interval of one hour. The columns in the right hand corner show the changes occurring in the percentage of hemoglobin, number of red and white blood cells, percentages of polymorphonuclear cells and lymphocytes at the beginning and at the end of the treatment. In addition the determinations of the sugar, nonprotein nitrogen and chlorides in the blood are also indicated before and after treatment.

these conditions the electrical field produced in the region between the electrode and the condenser plate opposite to the one near which the auxiliary plate is suspended, is considerably higher than it is at any other part of the body. When the region to be heated is located asymmetrically in the body of the patient, the pick-up plate is brought near the condenser plate opposite to the affected side. If the region is centrally located in the body, the pick-up plate is shifted from one side to the other. The localization may also be accomplished in regions where there is no convenient cavity by the use of surface electrodes. With this technic it has been possible to develop temperatures reaching between 110°F . and 116°F . as indicated by a mercury thermometer inserted in the vaginal electrode.

Regulation of Patient Prior and During Treatment

In preparation for the treatment the patient is given an enema in the early morning. Breakfast is limited to fluids. The treatment is started early in the morning inasmuch as it frequently covers a period of several hours during which time no food is

administered. After the patient is placed in the radiotherm he is reassured by a description of the sensations which he will experience. He is carefully covered with towels to absorb the perspiration. The mouth and rectal temperatures, pulse and respiration rates are observed and recorded every ten or fifteen minutes. About 15 minutes after the current is turned on the patient begins to perspire and states that he feels warm. With the continuation of perspiration the towels may become moist and must then be changed or else there may be an unpleasant sensation due to the arcing of the current. Individuals react differently to the treatment. They may complain of headache, of nausea, of shortness of breath, of palpitation, of thirst, or of a sensation of numbness of hands and feet. The face becomes flushed and the conjunctiva may become injected. There may be a palor of the skin in the region of the mouth.

After the temperature has been elevated as desired the patient is wrapped in blankets and transferred to the bed covered with a special heating hood. The temperature of the body is maintained, raised or lowered by turning the lamps in the hood on or off.

Observations of temperature, pulse and respiration are continued at ten to fifteen minute intervals. The patient is given fluids such as tea, lemonade, or water, even though nausea and vomiting may occur. The perspiration continues and the urine becomes scant and highly colored. Respirations vary: they may be rapid or slow, deep or shallow. An ice-cap or a cold damp towel may be applied to the head. To counteract the restlessness and discomfort we have administered various drugs, such as sodium amytal, chloral hydrate, morphine sulphate and pantopon. To prevent excessive perspiration, small doses of atropine sulphate may be administered. In general, the use of drugs is avoided as much as possible so as not to mask the patient's reaction to the treatment. When the treatment is ended the patient is permitted to cool off gradually before he is returned to his room or ward, there to receive fluids or a light meal. Hyperthermia treatments particularly if they are prolonged and strenuous, are uncomfortable, but the relief of symptoms in selected cases is often so marked that the patient frequently requests further treatment as soon as possible. Treatments are usually administered every other day. The intervals between treatments vary with the patient, with the character of his disease and with the height and duration of the temperature elevation.

Effect of Treatment

The effect of the application of radiotherapy can be explained on the basis of heat production. The first scientific investigation of the effect of the oscillating field on living cells was reported by Gossett and his co-workers (1924). The work of Schereschewsky (1926) indicating that certain wavelengths (those between 15 and 3.8 meters) have a specific lethal action upon living cells not attributable to the heating effect accompanying the radiation appears to be disapproved by the investigations of Christie (1929), Kahler (1929), and others.

The radiations of 1.9 meters independent of the heat factors have been shown to cause an attenuation of diphtheria toxin as assayed by skin tests in guinea pigs, the toxicity being so diminished that twenty-five skin test doses injected intradermally gave the same reaction as that obtained with one

skin test dose of the control toxin (Mellon, 1930).

There are two characteristics peculiar to the method of production of heat by radiotherapy that are significant in its application to medicine. First, that the heating takes place throughout the interior of the body; from within outward instead of from without inward. This makes the use of short-wave heating by "radiotherapy" a far more effective method of heat treatment than by conductive heating. Second, the heating is not produced uniformly throughout the heterogeneous tissues of the body. Prediction of the selective heating effect is possible from a knowledge of the characteristic electric constant of the different substances of the body, and also, by a suitable choice of wave length the heating of a particular part of a heterogeneous body may be favored over that of neighboring regions (McLennan, 1931).

The occurrence of such selective heating in the living animal is a matter of question because of the heat equalizing influences of the circulation. It has been shown that in the live, anesthetized dog with viscera exposed, the different organs heat up at approximately the same rate, the blood serving as a very efficient distributing mechanism of the generated heat, while in the dead dog the different organs heated up at different rates (Mortimer, 1931).

The production of heat in the human body sufficient to cause an elevation in its temperature produces profound changes in the physical, chemical and biological processes.

Effect on the Cardiovascular System

With the rise in temperature there occurs an increased pulse rate. The rapidity of the increase is greatest as the temperature becomes elevated. The rate of contraction in the excised perfused mammalian heart is increased when its temperature is elevated. In man, reflex factors enter additionally. With hot baths Bazett (1924) found a mean increase of 37 beats per minute for a rise of 2° C. In our experience the rate of increase varied from 7.4 to 30.6 beats per minute for each rise of one degree centigrade. There is an increased minute volume. The velocity of the blood flow is increased. The effect of temperature rise on blood pressure causes first a slight elevation

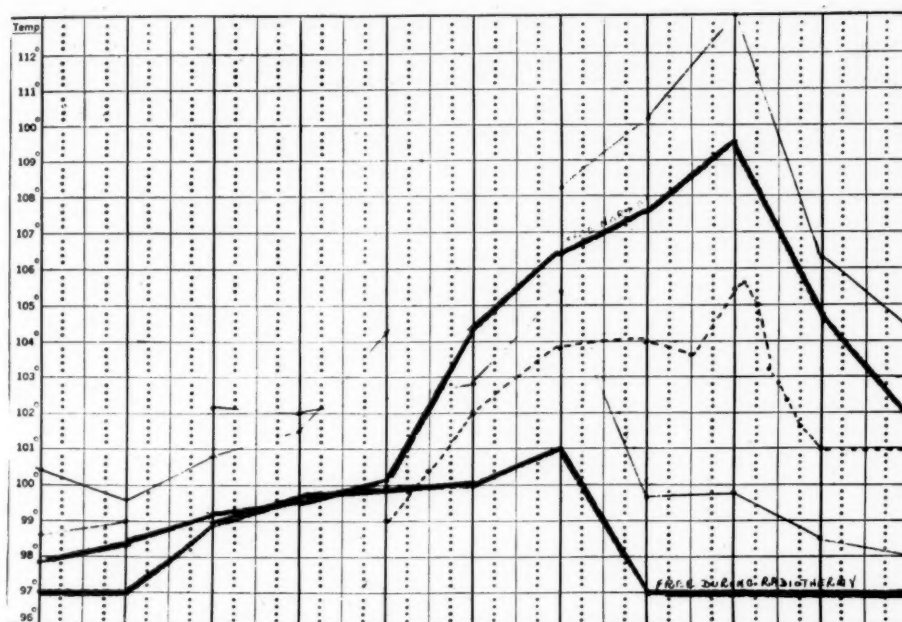


Fig. 3. Illustrates the changes occurring in the gastric secretion as the result of the induction of hyperthermia by means of the radiotherm. The upper two lines indicate the total and free acid determinations made as the result of the examination of fractional extractions following a test meal when the patient's systemic temperature was normal. The lower two lines (on the right hand side of the illustration) indicate what happened to the total and free acid when the systemic temperature had been elevated to the height indicated by the broken line. You will note that the free hydrochloric acid rapidly falls to zero and the total acid falls to a very low figure.

in systolic pressure, which subsequently falls, and a lowering in diastolic pressure. In many instances we have heard the pulsations when employing the ordinary auscultatory method while the mercury in the manometer went all the way to the zero mark. The number of white blood cells becomes increased during the period of temperature elevation. The percentage of polymorphonuclear cells is increased and that of the lymphocytes correspondingly lowered. There appears to be an actual increase in the leucocytes, probably due to the stimulation of the hematopoietic system. At first there may be a temporary decrease in the number of white blood cells. This may be an expression of blood dilution. As the temperature becomes elevated there is an increase in blood volume and subsequently as sweating continues, a concentration occurs (Eckhart, 1920), (Cohn, 1919), (Barbour, 1921). The initial increase in blood volume is due to fluid absorbed from other parts of the body; from the muscles, the intestinal tract, and the subcutaneous tissue. A diminution of brain volume has also been described (Kestner & Gross, 1919), (Barbour,

1924). The rate of locomotion of the leucocytes is affected by temperature to an extent similar to that of a chemical reaction. The maximum rate was reached according to McCutcheon (1923) at 40° C. Besides the increase in the number of red blood cells there is in many instances a marked increase in the immature forms of red cells suggesting a stimulation of the hematopoietic system (Knudson, 1931).

Vasomotor Changes

When any part of a skin surface is exposed to temperature changes there occurs a vasodilatation in response to warmth and a vasoconstriction to cold. There occurs considerable change in the veins, the skin becomes red and capillary pulsation may be observed (Lewis, 1924). A rise of temperature caused local dilatation of the capillaries (Krogh, 1919). The capillary pulsation is mainly the result of arteriolar dilatation, which is also demonstrated by an increased volume of the part warmed (Amitin, 1897), and also by more rapid local circulation rate (Stewart, 1911). In addition to the direct action of the heart, a nerve and chemical

mechanism is involved. After nerve section in man there was noted a marked redness and increased surface temperature in the affected area during the first few days. But after this the condition changed to one where the difference was slight but in which a surface temperature of the affected area was slightly higher in a warm room and lower in a cold one than that of the normal surrounding skin (Trotter and Davies, 1909). Lewis and his co-workers have advanced the hypothesis that the reddening of the skin may be initiated by some substances of the histamine type, since, if the circulation be temporarily arrested and later released, a delayed heat hyperemia may be seen even in a limb which has in the meantime been cooled (Lewis, 1924).

Goldschmidt and Light have shown that the venosity of venous blood returning from a limb depends upon the balance between the metabolism and the rate of the blood flow. Both of which are increased by a rise in temperature. These changes are not parallel. At high temperatures the circulation rate was increased so greatly that the venous blood contained large amounts of oxygen even though the metabolism was undoubtedly much increased (Goldschmidt and Light, 1925). When the temperature is elevated not only is there a change in the oxygen saturation of venous blood but physico-chemical factors are brought into play which considerably modify gas tensions by liberating the dissociation of oxyhemoglobin and by modifying the acid-base balance and blood pH (Bazett and Sriyatta, 1928).

Landis has shown in man that the capillary pressure is definitely raised to a considerable degree. Thus while in the skin of the finger he obtained, under normal room conditions, a pressure of about 32 mm. Hg in the arteriolar limb of capillary loops and about 12 mm. in the venous limb, he found these values raised to 60 mm. and 45 mm., respectively, when the skin temperature was raised to about 42° C. (107.6° F.). Since the osmotic pressure of the plasma proteins in man is about 26 mm. Hg, this implies a filtration pressure of oedema formation equal to the difference, or some 25 to 30 mm. of Hg. Presumably this fluid would drain away through lymphatics, under normal conditions (Landis, 1930).

Effect on Respiration

The respiration rate is increased with temperature elevation. In our experience this increase averaged from one to seven excursions per minute for each degree centigrade of temperature elevation. According to Bazett (1927) with the rapid rise in temperature hyperpnoea develops. The tidal air is increased up to two liters. This increased respiration is accompanied by definite sensations of air hunger. Haldane (1905) has shown that the hyperpnoea caused a marked fall in alveolar CO₂ tension.

Effect On the Skin

The temperature of the skin varies considerably in different parts of the body. We have noted these variations to be from 24° C. to 35° C. According to Bazett any individual is abnormal whose surface temperature is as high as 36.5° C. (1927). Variations in temperature affects the skin by causing alterations in its vascular condition, sweating with evaporation of water, a loss of CO₂ and pilomotor changes.

In the body's attempt to prevent temperature elevation it makes use of several heat regulatory factors. Evaporation of water from the lungs and skin as well as transference of heat from the body surface by radiation, conduction and convection. These factors are favored by an increased blood flow through the skin. The vasomotor shifts of blood, to the surface at the expense of the interior, are enhanced by augmented blood volume brought about by rapid dilution (Barbour, 1919). We have frequently observed the occurrence of herpes on and about the mouth and nose twenty-four hours after the application of radiotherapy.

Effect on Sweat Glands

In the process of heat regulation and equalization, water is well suited for it ranks high in three qualities: first, specific heat capacity which favors storage of heat; second, heat of evaporation which permits a very rapid elimination as when the environmental temperature exceeds that of the body; third, conductivity, which allows the rapid equalization of heat within the fixed tissues of the body, minimizing the possibility of injury from local overheating from within or without. Water, therefore, is the central factor in the regulation of bodily

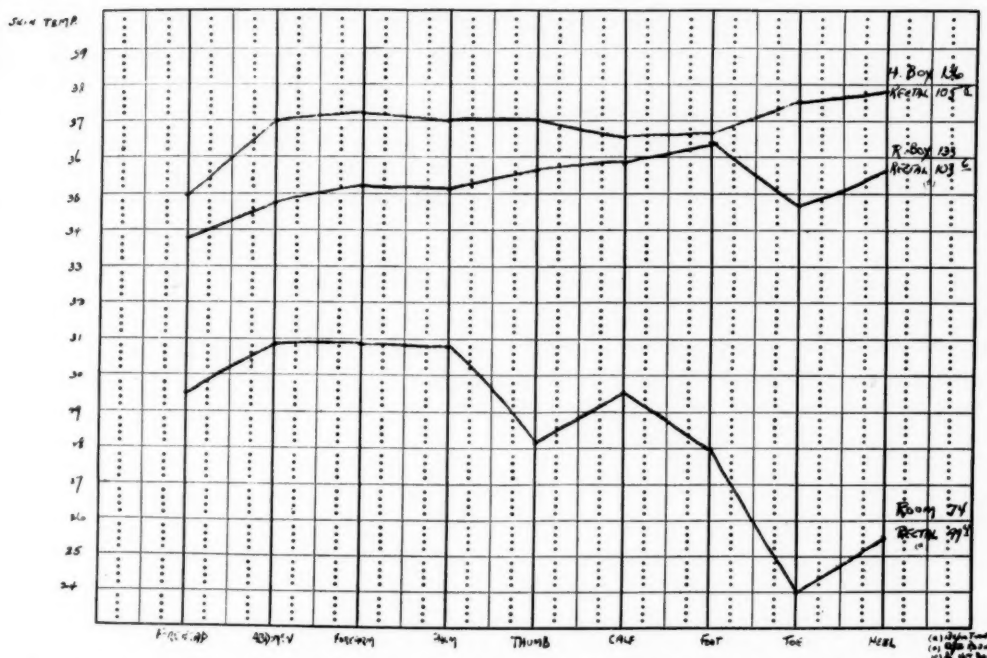


Fig. 4. Illustrates the skin temperature of various parts of the body as the systemic temperature becomes elevated. The lowest line in this illustration indicates the temperature of the skin at various parts of the body before the systemic temperature is elevated. The middle line indicates the same determinations when the rectal temperature has become raised to 106°F . and the top line indicates the same thing when the systemic temperature has been raised to 105.8°F . The two things of special interest in this illustration are the change in the heat gradient as the body temperature becomes elevated (the lower extremities at first the coldest parts become the hottest) and the fact that the hottest point on the skin surface was below 38°C . when the rectal temperature was 105.8°F . or 41°C ., a difference of more than three degrees centigrade.

heat (Henderson, 1913). For the initiation of the processes which regulate overheating no rise in blood temperature is necessary, sweating beginning prior to changes in rectal temperature (Filehne, 1910). We have observed that patients lose as much as five pounds in weight as a result of a single treatment. This probably is mainly accounted for by the loss of fluid in the form of sweat. Sweat is water with a low concentration of sodium and potassium chloride. The concentration of the chloride tends to rise if sweating is prolonged (Adolph, 1923). As sweating continues the acidity of the sweat diminishes (Bazett, 1927). The pH of the human sweat varies from 5.2 to 6.6 according to Talbert (1919), from 6.5 to 7.3 according to Adolph (1923), and from 6.0 to 6.9 according to Bazett (1924). The loss of CO_2 from sweat influences the determinations of pH. The fluid required for the production of sweat comes from the blood and indirectly from the muscles (Kestner, 1919), from the intestinal tract, and from the subcutaneous tissues (Hamilton, 1925).

Large quantities of lactic acid are lost in sweat (Bierman and Fishberg, 1932).

Effect on Permeability of the Cells

Vonkennel (1929) states that in malaria therapy the normal vesiculation time of eleven or twelve hours (the time elapsing between the application of a cantharides plaster to the thigh and the appearance of vesicles), is reduced during the height of an attack of fever to five or four hours. Following the crisis, the vesiculation time increases to five or six hours and in the fever-free interval it remains at from six to seven hours. On the basis of these facts the author concludes that the increased permeability of the cells of the human organism is an important factor in the action of modern fever therapy. The permeability of the lymphatic capillaries in the skin is increased when the temperature of the part is raised (Hudack 1932).

Effect on Metabolism

Variations in temperature have been demonstrated to affect the velocities at which many bodily functions are performed

to an extent which is similar to that produced by temperature changes on the velocities of chemical reactions. This similarity has been taken as evidence that the velocity of such functions is determined by some fundamental chemical reaction even though similar high coefficients may be observed in some physical processes (Gasser 1924). According to DuBois (1921), on exposure to excessive warmth, heat is increased due to the actual rise of the temperature of the tissues and the consequent greater velocity of their chemical changes. The increase in metabolism follows the temperature law of Van't Hoff, which means that for every rise of 10° C. the rate of oxidation is increased 2.5 times. When the regulation against overheating fails and the body temperature rises to any considerable extent there results an increased metabolism (Schapals 1912). There occurs an increase in the blood sugar content in fever but this is of such a degree as may well be accounted for by blood concentration (Freund 1913). We have observed increases in the percentage of blood sugar, nonprotein nitrogen and blood chlorides which may be explained on a concentration basis. Knudson and Schaible (1931) in experimenting on dogs, found that on producing hyperthermia by means of radiotherapy there was a decrease in blood volume amounting in some experiments to 25 per cent. Weight and blood volume usually returned to normal in 24 hours.

These investigators also found that raising the temperature in animals to 41.7° C. does not produce any great change in hydrogen-ion content of the plasma, although there is a tendency toward a condition of alkalosis. With higher temperatures the tendency is toward a condition of acidosis, apparently caused by great increase in the production of lactic acid. The increase in lactic acid is probably due to a greatly increased tissue anoxemia. Changes in the chloride, total protein and total base are accounted for by the dehydration. Bicarbonate was greatly reduced owing to excessive pulmonary ventilation with rise in body temperature. Changes in the inorganic phosphorus were somewhat variable, although with a maximum temperature to 41.7° C. there is a marked reduction. In these

experiments on dogs they found that the nonprotein nitrogen of the blood is generally increased; in some instances the increase is over 200 per cent. Urea nitrogen, creatinine and amino-acid nitrogen are also increased. These increases are accounted for by the increased metabolism resulting from a rise in temperature and the oliguria. The blood sugar content in most of the experiments showed an increase in some cases amounting to as high as 150 per cent. The greatest increase in blood sugar occurs in those experiments in which the hydrogen-ion concentration has been lowered the most.

Effect on Hydrogen-Ion Concentration—Koehler (1923) demonstrated that both in febrile cases and in experimental hyperthermia the diminution in alveolar CO_2 tension is accompanied by an alkalosis. Development of alkalosis has also been described as a result of pyrexia caused by diathermy (Bischoff 1930). Changes in the pH of 0.23 to 0.33 to the alkaline side with attainment of plasma pH values as high as 7.70 and 7.74 have been described (Bazett 1932).

Effect on Gastric Secretion. The gastric secretion is reduced in fever (Meyer 1918). We also have observed a marked diminution of both free and total acidity as the result of temperature elevation.

Effect on Muscle and Nerve. Elevations of temperature have been shown to affect the refractory period of muscle (Bazett 1908), and of nerve (Adrian 1926), as well as the chronaxie of muscle (Filon 1911).

Effect on Growth and Reproduction. Exposure of young rats to an ultra-high frequency field for periods of from one-half to one hour daily and raising their body temperature to 40.5° C. (the normal rat temperature is 37 to 37.5° C.) does not seem to retard their growth appreciably. The reproductive organs of male and female rats are not appreciably affected so that there is no loss in power to breed. Repeated exposure of rats to an ultra-high frequency field in which the body temperature is raised 40.5° C. does not produce any abnormal pathologic lesions (Knudson and Schaible 1931).

Effect on Tissues. Jacobsen and Hosoi discussed the morphologic changes occurring in tissues as a result of development of high

temperatures by means of radiothermy. They found congestion of the organs, peripheral hyperemia, cloudy swelling, fatty degeneration, dehydration, glycogen depletion, focal hemorrhages, especially in the gastrointestinal tract, epithelial hyperplasia in the parenchymatous organs, and stimulation of the bone marrow. Following prolonged periods of heating, degenerative lesions occurred in the male germinal epithelium. Alterations as observed differ but little from the effects of fever produced by various other methods (Jacobsen and Hosoi 1931).

Effect of Temperature Elevations on Micro-Organisms. Forty-eight hour cultures of 15 strains of *N. gonorrheae* were placed in vials, sealed and subjected to water bath temperatures ranging from 37.5° to 42°C. Such temperatures as 40°, 41.5°, 41°, and 42°C. destroyed this organism as determined by culture methods (Boak, Carpenter and Mucci 1932). Extracts of rabbit testes injected with *Treponema pallidum* were placed in vials sealed and immersed in water baths at temperatures ranging from 37.5° to 42°C. The intratesticular inoculations of extracts so treated demonstrated the lethal effects of certain time temperature combinations. Rabbits infected with *Treponema pallidum* and later given similar fevers by short radio waves failed to produce syphilis when their testicular extracts were injected into other rabbits (Boak and Carpenter 1932).

Mechanism of Heat Regulation

Temperature regulation occurs only in those species which have a highly developed nervous system. The existence of a thermostat-like nervous mechanism at the base of the brain is indicated by the demonstration that warming of the region of the corpus striatum in rabbits reduces the rectal temperature while cooling has the opposite effect (Barbour 1912).

With the exception of respiration, all the factors concerned in the heat regulation of warm blooded animals are under the direct control of the sympathetic nervous system and therefore subject by the functional activity of the thyroid and adrenal glands. Since heat regulation is a function of the sympathetic nervous system, the so-called heat center in the tuber cinereum is explicable as a group of nerve cells represent-

ing the central connections of the sympathetic (Cramer 1928). It has been shown that dehydrating a dog with intravenous injections of concentrated dextrose solution produces very high temperature attributable to concentration of the blood and lack of water available for giving off heat (Balcar 1919). In the maintaining of the body temperature after we have raised it by means of the radiotherm we remove our patient to a bed where we can apply heat from carbon filament lamps. This permits us to maintain a desired temperature and to even send it higher if the indication so warrants. A possible explanation for the ease with which elevated systemic temperatures may be maintained by the application of small quantities of heat may be the occurrence of blood concentration during the period of temperature elevation.

The production of pyrexia by means of the electric current differs from that developed in infectious fevers. The heating caused by the high frequency field (electromagnetic) may be due to ordinary resistance losses such as would occur with low frequency. The two losses may be distinguished by investigating the effect upon the heating due to changes of frequency. Due, however, to the complex nature of the resistance presented by the body cells, enclosed as they are in dielectric membranes, the problem of distinguishing between the two effects becomes extremely difficult. In any condenser where the dielectric is perfect the charge is instantaneous with, and in proportion to the applied voltage and the capacity of the condenser. Where the dielectric is imperfect there are three possible situations: First, where dielectric imperfections are of the nature of resistance the charge is still instantaneously proportional to the voltage between the plates, but contrary to that of the perfect condenser there is also a flow of current in proportion to the voltage between the plates. This flow of current is the source of heating in this type of condenser. Second, where the dielectric has imperfections in the nature of hysteresis the charge on the plate is at no time proportional to the voltage between them. There is a lag between plate voltage and the appearance of the corresponding charge due to a sort of electrical viscosity of the dielectric. To overcome this lag, or in other

words, to cause the charge to alter its sign and magnitude completely once each cycle, necessitates the expenditure of energy which shows itself as the heating of the dielectric. Third, where the dielectric may have imperfections of both types, which is the real situation in actual dielectrics, one or the other may predominate or both may be so slight that for all practical purposes we may say that the dielectric is ideal.

In radiotherapy the heat producing energy is poured into the body from an external source. In infectious fevers the heat is produced from sources within the body. There occurs a failure of heat elimination. The surface of the body becomes paler and the perspiration is diminished during the fever rise. The blood flow through the periphery is decreased (Barbour 1921). The explanation of the occurrence of infectious fevers is that it is due to a provocative poison reaching the tissues and initiating catabolic changes which increase the affinity of the tissue for water. This general demand upon the blood for water tends to reduce the blood volume especially at the expense of the surface blood. The skin immediately becomes cooler and thus arouses the nervous regulation against cold, thus exaggerating the process of vasoconstriction and hemoconcentration (Barbour 1921).

Effect of Chemicals on Heat Regulation

Drugs which are usually classed as depressants in general reduce the body temperature in all cases where the environmental conditions are normal. This is seen particularly in the case of alcohol and the general anesthetics, as well as with morphine. These substances usually favor blood dilution and peripheral dilatation (Barbour 1921, Vol. 2). Chemicals may produce fever. The controlling factor is presumably anhydremia. The fate of the water varies with the different drugs. Diuretics produce anhydremia by causing loss of water chiefly through the kidneys. The purines especially theophyllin concentrate the blood (Spiro 1918). Caffeine increases body temperature of animals deprived of their heat centers (Isenschmid 1913-1920). Fever inducing cathartics, like aloin promote a loss of water by way of the alimentary canal (Berrar 1913). The intravenous injections of 3 per cent but not of the normal saline solution

always increase the temperature in rabbits (Rolly and Christiansen 1914).

Comment

We have administered about 450 treatments to a little more than 100 cases. We think radiotherapy to be of value in the treatment of certain neurologic conditions such as paresis, tabes and multiple sclerosis. Other workers have described its value in the treatment of paresis (Hinsie 1932) and of multiple sclerosis (Schmidt 1931). We have also used it to advantage in the treatment of polyradiculitis, postencephalitic Parkinson's and chorea. Excellent results have been reported in the treatment of chorea by means of typhoid and paratyphoid vaccine administered intravenously (Sutton 1931). It appears that equally good results can be obtained by means of radiotherapy. In the treatment of arthritis, particularly of the gonorrheal variety, radiotherapy is a valuable therapeutic agency. We have treated our cases of gonorrheal arthritis by means of the special localization technic applied to the region of the prostate in the male, and to the pelvis in the female. The subject of infectious arthritis is a complex one. In the treatment of this condition radiotherapy will take its place as a valuable adjunct along with other therapeutic procedures. Some cases of thromboangiitis-obliterans have been benefited while others have not been improved. A case of Raynaud's disease has improved. In the treatment of these vascular diseases the maximum temperature which can be developed is not necessarily the optimal one. Cases of rheumatic fever in children have not been particularly benefited. In the treatment of subacute pelvic inflammatory disease of both gonorrheal and non-gonorrheal origin the application of radiotherapy with the special localization technic has proven very satisfactory (Bierman and Horowitz 1932). We have applied radiotherapy to several types of skin diseases. We have noted improvement in some cases of scleroderma and of psoriasis. The beneficial effects in one case of Kaposi-skin-sarcoma and one of mycosis fungoides were marked but transient. Good results in the treatment of asthma by electrically induced fever have been reported (Feinberg and Osborne 1932).

Contraindications to the use of radiotherapy will naturally vary with the degree of temperature elevation. A degree or two of systemic elevation will not throw as much of a burden on the cardiovascular and other systems of the body as would temperature elevations of several degrees. Severe organic lesions diminish the body's ability to respond to the additional load placed upon it when its temperature is elevated.

Our experience with the therapeutic production of hyperthermia leads us to feel that by applying this procedure we are taking a leaf out of nature's note book. We have veered from the old point of view that fever represents a harmful condition which must be combated by hydrotherapeutic applications and by antipyretic drugs, to the realization that by means of an elevation of systemic temperature the body increases its defense activities. It would be of interest to discover why the body develops temperature elevations characteristic of certain diseases. Why do the peaks and valleys of temperature reactions occur in septicemia and why the sustained plateau of typhoid fever?

Summary

The use of radiotherapy permits us to raise the systemic temperature and to maintain it for any desired length of time. The character of the temperature curve may therefore be changed at will. Our experience indicates that we may vary the character of the hyperthermia produced as we desire to secure one effect or another, in combating various diseases. With some we shall want high and sustained temperatures as in accomplishing a thermo-lethal influence upon the invading organism such as the gonococcus. In others we may find that a mild degree of systemic elevation is most desirable as where we aim at the dilatation of peripheral blood vessels as in the treatment of a condition like thrombo-angiitis-obliterans. In the treatment of other diseases as where we desire an increased leucocytosis or an increased tissue permeability, a mild temperature elevation may be sufficient. In still others we may find it best to create a mild degree of systemic temperature elevation with a high degree of localized heat. Such an arrangement may correspond to the condition existing when a

localized area of infection occurs in the body.

With the refinement of the technic in causing hyperthermia by a controllable physical agency such as radiotherapy, we shall find that we are in possession of a promising new and valuable therapeutic instrument.

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PLACE OF DIATHERMY IN THE CANCER PROBLEM *

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I am well aware that in discussing any part of the cancer problem from a new viewpoint I am treading on dangerous ground. It is a remarkable fact that in no other branch of medical practice have the results of modern research work been so little utilized as in the cancer problem. The uncertainty concerning the essentials of the cancer question has led to the acceptance of some axiomatic assertions, in other words we have substituted traditional beliefs for knowledge, thus blocking the avenue to advance. There are two main inherited teachings that kept our reasoning in traditional ruts. One, that cancer in its initial stages is a strictly local disease, the other, that cure may only obtain by the complete regional destruction of the tumor, the so-called radical operation.

Without going into the details of all the pertinent research work I should like to

state that more and more modern reasoning points toward the conviction that cancer even in its earliest appearance is never a strictly local disease but the local manifestation of a general disorder, and that the production of systemic reaction is just as important a therapeutic factor as the regional destruction of the tumor.

The same deficient reasoning originally was applied to diathermic intervention. We noticed only the results without properly analyzing the causes of success or failure.

Visualizing the results of electrocoagulation as superior over those obtained by other forms of surgery, under the pressure of traditional beliefs only the technical side of the problem was considered and theories were advanced helpful in emphasizing the pre-eminent importance of extensive local destruction.

It was claimed that cancer cells show a lower resistance to heat than other cells and that electrocoagulation prevents dis-

* Read at the Tenth Annual Meeting of the American Congress of Physical Therapy, Omaha, Nebraska, Oct. 6, 1931.

seminative implantation of malignant cells. Clinical and post-mortem research has disproved the first assertion, and nobody as yet has succeeded to prove beyond doubt the successful implantation of viable cancer cells in the human body.

Advantages of Surgical Diathermy

Now what are the facts in application of diathermy to cancer? The technical superiority of electrocoagulation over the galvanocautery and the soldering iron is obvious. The amount of heat is under the absolute control of the operator and our regulating devices guarantee an orderly proceeding of the whole operation. On the clinical side we see a very low primary mortality, a minimum of surgical shock and prompt improvement of the general condition. It may also be mentioned that the diathermic operation is practically a bloodless one and that tumors may successfully be attacked which for technical reasons are not manageable by the knife. The degree of heat produced sterilizes the field of operation, thus interfering with the dissemination of streptococcus infection, which so often impairs the results of cutting operations. It is almost unnecessary to mention that the majority of ulcerating cancers are infected by streptococci. The sealing of the surrounding lymph-spaces reduces the surgical shock, a complication mainly based on the absorption of the end-products of destruction produced by any surgical intervention. Scientific analysis of the favorable results of surgical diathermy demonstrated the fact that its greatest therapeutic merit consists in exciting a localized systemic reaction. The modern biologists determined the fact that practically all the defensive forces of the body reside in the macrophages of the reticulo-endothelial system.

Function of Reticulo-Endothelial System

Animal experiments, biopsies and post-mortems revealed that around the structures necrosed by electrocoagulation there develops an area in which these macrophages appear in abundance, an area which we call the perithermic zone. The appearance of these cells in this zone is due to their migratory tendency, because they are attracted to any area of the body in which an increase of metabolism becomes established, and travel from their original location to such a

spot. These macrophages are not only able to digest particulated matters but they also absorb with great avidity and destroy toxins. It was also found that their functional capacity may be increased by the imbibition of certain proteins. But a sudden inundation with streptococcus toxins destroys the vitality of these macrophages. It was demonstrated beyond all doubt that these macrophages are able to disintegrate cancer-cells. That this destructive action in a great many instances is not completely successful may be explained by the fact that as a rule the macrophages do not appear in sufficient numbers and that their functional capacity is not worked up to the highest pitch.

It was already mentioned electrocoagulation is in short order followed by abundant immigration of macrophages into the perithermic zone. But it is also important after once the primary reaction has subsided, to maintain the local increase of metabolism with its subsequent attraction of macrophages by repeated applications of medical diathermy to the region involved. It is highly probable that the activity of the perithermic zone accounts for the fact that previous electrocoagulation enhances the efficacy of following radiotherapy. This is most convincingly demonstrated by accomplishments in cervical cancer. This combined method furnishes results that surpass the results of any other intervention and that in great many instances of apparently hopeless cases.

The stimulation of the functional capacity of the macrophages is brought about by administration of proteinotherapy. Previously to the electrocoagulation the patients resistance is built up by protein injections that are continued after the operation.

The reinjection of the patients own blood was also found to be of great service. In further development of the proteinotherapy two fundamental points have to be considered. One is the law of specific reciprocity within the body.

Law of Specific Reciprocity, and Morphologic Balance

We know that certain cell groups in their function are influenced solely by the emanations of certain other cell groups and by no other ones. This physiologic fact is recognized as the action of hormones, compounds that excite function, while other

compounds called ferments regulate the functions created; if they act in connection with pathologic processes we call them defensive ferments. It becomes more and more apparent that among the factors causing cancer, disturbance of the equilibrium between stimulating and regulating forces is a prominent one. It therefore will be necessary to produce and maintain a superior force of regulating ferments, again a task of proteintherapy.

Secondly it has to be considered that the morphologic structure and microscopic appearance of a cancer is not an intrinsic criterion of its malignancy. This characteristic quality is much more dependent on the organ carrying the tumor, whose pathologic physiology is influenced by the normal physiology of the cancer carrying organ. As a striking support of this concept may be quoted the clinical experiences with uterine cancer. While adenocarcinomata of the portio and cervix uteri are generally considered to be preeminently malignant and in a great many instances refractory toward therapeutic efforts, adenocarcinomata of the uterine body furnish just as favorable a prognosis as any other variety of cancer in this locality. It therefore will be necessary to determine and employ specifically selected proteins for each individual groups of cancers.

One part of the problem indicated is already pretty close to its solution. As mentioned before we are able to attract macrophages to the vicinity of the cancer by producing through electrocoagulation the perithermic zone. But we also succeeded in exciting an overproduction in their original location of these defensive cells by the administration of enzymes. Thus we are in a position to draw on a surplus of these macrophages.

We are working now on the other part of the problem, that is the determination of proteins which in a given instance are apt to raise to the utmost degree the functional capacity of the macrophages and of compounds that will stimulate the production of defensive ferments.

This whole edifice, of course, is not yet a finished product, but I am confident that we have constructed a solid foundation for further upbuilding of rational chemotherapy of

cancer, a therapy whose basic principle will be reconstruction and not destruction.

Discussion

Dr. J. E. Summers (Omaha, Nebr.): The essayist has remarked that cancer is never strictly local, but the manifestation of a general disorder. That, I believe, is true. Only today in looking over some of my books on cancer I came across one written in 1805 by Sir Everard Home, the brother-in-law of John Hunter, in which he described cancer just as the doctor has today, a constitutional disease with a local manifestation. Treatment, therefore, should be both local and constitutional.

As Dr. Kolischer has pointed out, the technical advantages of diathermy over galvano-cautery and soldering iron are: Better control; prevents streptococcic infection; lessens shock. Take the cautery. The danger of a bad burn is the absorption from the burned tissue, so the lessened shock with diathermy is much more marked than where the cautery is used. It produces a systemic reaction by stimulating the macrophages (phagocytes) of the reticulo-endothelial system.

The area of macrophages is increased by electric coagulation. They destroy toxins, digest particulated matter; that is, the cancer cells. Their action is increased by the imbibition or absorption of certain proteins. The activity of the perithermic zone is increased by medical diathermy.

By the way, I was in San Francisco just a year ago and I read of a new diathermy machine by which they could send through space a temperature of 108° F. The idea was that this temperature was so high it would kill any cancer cells that might be within the body, or inhibit them so that these phagocytes probably would absorb them and they would be destroyed.

Here is something that is very interesting, and I can't quite get it. The hormone compounds that excite function must be regulated by certain ferments, and this is a task of protein therapy. Special proteins must be formed for individual groups of cancer. The doctor then says, "Individual protein therapy for individual cancer is the goal of this thesis."

Of course, it is a big job to get an individual protein for each type of cancer. Cancer of the tongue is one which he mentioned. I don't know how that could ever be accomplished, and yet I suppose it has been. The only disappointing thing is that the doctor didn't give us some individual experience to enlighten us so that it might lead us forward to even more interest to take this thing up from his viewpoint.

I have had some experience with experimental work in cancer in the human being, inoperable cancer. My experience with protein therapy is rather in what I would call the chemical type. For instance, the turpentine abscess of the French, or one of my own—I say my own, accidentally so.

Some ten or twelve years ago I was experimenting with cancer using calcium chloride intravenously when a woman was brought to the

Clarkson Hospital—if I may be permitted to tell this story because it is real interesting—carried on a litter, with a distended abdomen and cancer masses and fluid in the abdomen, utterly bedridden. She had been operated on a year or two before and a cancerous tumor was removed from an ovary, which was proven microscopically. I said, "What did you bring this woman in for? I can't go anything with her." Then I thought I would try my calcium. I injected it subcutaneously. It produced a big area of inflammation, the skin was red, and she had a temperature of $103\frac{1}{2}^{\circ}$ F. I did that several times, and then what happened? This mass in her abdomen gradually disappeared like snow under a sun and we all watched with a great deal of interest. The woman got to be such a nuisance walking around the wards and halls with a shawl around her shoulders, that we were glad to see her go.

I sent her home thinking we had discovered something. In a short time, about two months, she came back in the same condition. I tried to use the calcium chloride in the same way and couldn't raise the temperature. I couldn't get the antibodies to stay, and she later died.

I have had a number of such experiences. That is what I call a chemical action.

I might go on and talk for a good long while. I was very much interested in the American Journal of Cancer, which came out recently, in which it told of the Tumor Clinic, Jefferson Hospital, Philadelphia, Pennsylvania, trying lead phosphate with manganese, called the Bell Theory. They had a lead preparation to use in cancer, a very dangerous thing to use. It really did seem to kill the cancer germs. I am a believer in that to a degree. The Jefferson Hospital in Philadelphia sent out a partial statement on some twenty-five cases, and I think there is something in it, something very, very important.

Dr. Gustav Kolischer: About the idea that cancer is a constitutional disease, there is an individual predisposition and a predisposition of certain organs with certain influences which we can't explain, and yet of so many millions of individuals who are exposed to the same irritations, and so on, only a minority have developed cancer. There must be a general predisposition.

Now as to a local predisposition. We know that certain chemical irritations, for instance, will produce cancer. We know that cobalt produce cancer of the lung, and nowhere else. Here is a combination of individual predisposition and local predisposition. That incidental, contributive factors may help in producing a cancer is obvious. We know, for instance, that predilection exists in the narrow spaces of the intestinal tract, where naturally by their function there is extreme desquamation of the epithelial cells. A little irritation may be enough to produce proliferation that finally will end in the production of an epithelioma.

A very interesting observation was made some

years ago in a German Gynecological Clinic. If there is a cancer of the cervix and the woman becomes pregnant, the cancer will luxuriate. They showed three cases where during pregnancy the cancer receded and almost disappeared, which again shows a constitutional factor.

Chemical compounds, whether organic or inorganic, are known to influence cancer, as proven by clinical experience. We know that erysipelas made a sarcoma to disappear. We know that occasionally injection in cancer of colloidal gold or something else may influence a cancer favorably. We know if we produce an inflammation a sarcoma occasionally disappears. We are groping in the dark and, to a certain extent.

That is the reason why I say it will be necessary to discover the protein compounds which in the cancer will really produce the necessary reaction. That the reaction in the defensive cells depends on the character of imbibitions is proven by another fact.

While any cell in the body may become phagocytic, only the macrophages destroy toxins. If you inundate these cells with fresh culture of streptococci they will all die. Rabbits are very susceptible to streptococcal infection, and they develop typical disturbances mainly in and around the kidneys.

If we ever immunize, which can be done, by beginning with mitigated doses and gradually increasing, and finally injecting full power streptococcus culture, these animals will remain well and absolutely immune. That shows there is a possibility of educating these cells to their full faculty instead of killing them.

If we believe that cancer is a constitutional disease, then we have to treat it constitutionally. Our treatment of cancer up to the present time reminds me of what we used to do, when I was a student, for diphtheria. In those days all they did for diphtheria was to take a caustic pencil and cauterize the membranes showing diphtheria exacerbation. Now we use antitoxin and immunize the patient.

While there is absolutely no proof that cancer is produced by hostile invasion, but that it is a domestic affair, we know that all the organs of the body are controlled by certain endogenous operators. If it is possible that these organs control each other, it must be possible to find out how to control the excessive growth of cancer, because the cancer cell, *per se*, cannot be diagnosed as a cancer cell. There must be such a control, otherwise our teeth would grow out of our mouths. The goal is to find these regulating substances to the end that we may be able to destroy the cancer by biochemical means, or by the macrophages. We restore the balance between the stimulating and the regulating qualities. That is the future.

Nowadays we don't stumble any more. All must be developed on things we know. We have to put the facts together and try to use these facts which the theoretical men furnish us in our clinical work.

PELVIC IRRADIATION IN CANCER OF THE CERVIX *

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How are we to evaluate the various methods of treatment of carcinoma of the cervix? The answer is that in the present chaotic state of the world literature on the subject it is impossible to arrive at any definite conclusions.

The first total extirpation of the pelvic organs for carcinoma of the cervix was performed by Sauter, in 1821. Later, Wertheim and Ries evolved the extended abdominal operation and Schauta the extended vaginal operation. These operations rank among the most formidable known to surgery. In the beginning the primary mortality of these operations was appalling, and now after a lapse of twenty-five years, the results are far from satisfactory, though the cases are carefully selected and the operators are of the highest order.

Surgery of the most radical type, with its high primary mortality remained the sole method of treating carcinoma until the introduction of irradiation therapy. And now we are confronted with an array of therapeutic procedures that are as imposing as they are confusing. We find our highest authorities divided into at least six different groups and scarcely two in any single group using identical methods in technic. There are those who resort to surgery alone; others to irradiation alone and again there are those who operate and apply post-operative irradiation, others who do preoperative irradiation and finally there are those who combine preoperative with post-operative irradiation. In the field of pelvic irradiation we find one group using radium alone, another the x-rays alone, while others use both radium and the x-rays. The radiologic division of the Cancer Commission of the League of Nations finds the radiological institutes and clinics of the world varying in their technic so radically as to defeat all efforts at arriving at any definite conclusions.

In the effort to evaluate the merits of

surgery versus irradiation we must bear in mind that surgery is restricted to the more favorable group of cases and that the operation is of so formidable a nature that only the most experienced of gynecologists should undertake its execution. It is not an operation for the general surgeon and therefore is greatly restricted in its application.

Zweifel says: "It must be emphasized and clearly understood that proficiency in irradiation therapy is more difficult to achieve than proficiency in surgery." If we accept this dictum then we must conclude that proficiency in the management of cancer cases rests in the hands of the trained expert and not in the general profession.

My own preference is for irradiation and irradiation only. I have arrived at this conclusion as a result of personal experience and from a study of the world literature. The most impressive statistics yet published are those of Heyman, of Stockholm. Heyman collected 5,024 operated cases from 20 clinics and 3,512 irradiated cases from 17 clinics that were not operated. Of the operated cases there were 20.2 per cent of five-year cures as against 25.6 per cent of five-year cures in the irradiated cases. There was a primary mortality of 17.2 per cent in the operated group as against a primary mortality of 1.6 per cent in the irradiated group. But these statistics do not tell the whole story. Only 26.6 per cent of all cases in the clinics were chosen for operation, while all cases in the Radium Hemet were irradiated. Had only the early cases been selected for irradiation therapy the percentage of cures would have been more than doubled, as indeed they have been in the New York Women's Hospital. In the inoperable group, where surgery fails, we find irradiation affording a clinical cure for months or a year and more in a large proportion, and an absolute cure in 8 to 13 per cent (Wintz, Doederlein, Heyman-Forsell).

In favoring irradiation to the exclusion of surgery in the treatment of carcinoma of

* Read at the Tenth Annual Meeting of the American Congress of Physical Therapy, Omaha, Nebraska, October 8, 1931.

the cervix, I have in mind the availability of proficient service in the profession as compared with surgery. Other factors in its favor are the comparative safety of irradiation, the short period of hospitalization with little suffering, the shortened period of convalescence and above all, the adaptability of irradiation to all groups of cancer.

Ewing says: "It must be apparent to all that the very malignant grade 4 cancers of the cervix are never cured by surgery but give the highest proportion of radiation cures."

Krönig was first to adopt irradiation therapy in carcinoma of the cervix. He did so because he had become disheartened by the frightful primary mortality of surgery and the high rate of recurrences in operated cases. His reaction is similar to that of a host of able, conscientious surgeons the world over. I think we can all subscribe to the statement of Zweifel that "radiation therapy should always have a definite place in the plan of treatment for uterine carcinoma." This does not imply that surgery in selected cases and in competent hands should not be done.

There is a tendency on the part of many medical men to regard radium as a drug with only one method of application. This is unfortunate for irradiation therapy, but it is doubly unfortunate for cancer cases. The technic of irradiation therapy requires fully as much skill and experience as does surgery.

George Gray Ward lays great stress upon the advantage of a monthly inspection of these cases over a period of years. Clearly this falls within the domain of the gynecologist, for, in so doing, recurrences can be early recognized and often successfully combated.

Surgery, it would seem, has reached the

limit of its applicability; irradiation therapy may not be brought to much greater efficiency and the hope for further improvement in our results lies in the early recognition of cancer. Of more than passing interest is Zweifel's report of 87 per cent permanent cures in cases that were diagnosed early. Compare such a record with that of operators in general, who are obtaining no more than 20 per cent of absolute cures in all cases, and we of the medical profession are challenged to educate the laity to the end that they may become cancer-minded.

Discussion

Dr. A. F. Tyler (Omaha, Neb.): I think Dr. Findley's excellent presentation and treatment of cancer of the cervix has hit the nail on the head, because it shows definitely what can be done by this method of treatment. It is especially forceful when we consider that the paper is presented by a man who has followed purely surgical treatment for a lifetime and now has changed over to purely irradiation therapy.

The doctor has presented the argument in favor of radiation. Of course, in the first classification, which is definitely limited to the cervix itself, there is a choice of methods so far as actually getting rid of the growth is concerned. The percentage of living patients, however, greatly favor irradiation treatment because of the difference in the primary mortality. After that first class has been disposed of, there is no choice whatever. The argument is all in favor of radiation.

Sixty-four per cent of all cases that come to the doctor the first time are inoperable and cannot be benefited by surgery, so if there were no other place to use radium except in the inoperable type we would have a great majority of argument in favor of radiation.

I cannot cease the discussion without emphasizing the importance of proper technic in the treatment of these cases. The renting of a small tube of radium and sticking it in the cervix does not constitute proper treatment of these cases. It requires a knowledge of the physics of radiation so as to get a uniform dosage through the entire tumor, and where the perimetrium is involved I think the high voltage x-rays should also be used along with the radium.

THE SIGNIFICANCE OF THE PATHOLOGICAL AND ETIOLOGICAL FACTORS IN THE TREATMENT OF RHEUMATIC DISEASES *

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When medical knowledge developed beyond the ancient practice of designating disease forms by description of symptoms, pathological and etiological factors framed the background for the genesis of disease classification, thus forming a reasonable structure for therapeutic endeavor. The classification of rheumatic diseases has been particularly confusing. Although many debatable questions still exist, the dawn of a brighter outlook is now ahead of us. Certain pathological and etiological fundamentals seem definitely to have been established and the International Commission for study of the disease, is gradually bringing order out of chaos.

Dispensaries and hospital records do not indicate a full recognition of these progressive efforts, as empirical medication and routine removal of tonsils and teeth continue to be the first and last remedies. Similarly, our private case histories also show a distinct lag as regards the quality of diagnoses and treatment. Indeed, therapeutic intervention is still greatly influenced by symptoms, rather than casual and pathologic factors.

Accuracy of diagnosis is the keynote to successful therapy. Ability to differentiate the nature of fundamental disease processes depends upon a thorough knowledge of the pathological and causative tissue changes. This Hunterian principle applies particularly to rheumatic diseases. Let us therefore analyze the latest research developments along the following three diagnostic essentials:

1. The pathological characteristics.
2. The etiological evidence.
3. The anatomical and physiological significance of the parts affected.

Classifications of Pathologic Types

It has been estimated that there are about

* Read at the Tenth Annual Meeting of the American Congress of Physical Therapy, Omaha, Nebraska, Oct. 5, 1931.

thirty-five or forty forms of rheumatic diseases. These may be divided into two general classes, one, where the etiology may be differentiated, the other where the etiology is obscure and undifferentiated.

In the first division, the various forms usually derive their distinction by their etiological nature whether infectious, toxic, metabolic, traumatic or chemical. In the second division, the individual designations are more indeterminate since it long has been the practice to classify them by their clinical manifestations. Such terms as arthritis deformans, rheumatoid arthritis and gout are confusing because the etiologic and pathological distinction is not expressed.

The histological investigations of Nichols and Richardson in 1909 seem to have established two definite pathological forms of arthritic diseases which are fundamental. These are:

1. The proliferative type.
2. The degenerative type.

Other writers have used terms in recognition of these two forms as follows:

For the proliferative type:

1. Infectious.
2. Atrophic.
3. Rheumatoid.

For the degenerative type:

1. Osteoarthritis.
2. Hypertrophic.
3. Metabolic.

The terms proliferative and degenerative are preferable, because they express fundamental pathological states, whereas the other terms are frequently used to describe clinical and x-ray findings.

Pathological Differences in Joints

Nichols and Richardson show that in the proliferative type the synovial membrane is involved, while in the degenerative type the process seems to be a primary wearing away

of the cartilage accompanied by hypertrophic bone growth along the borders of the joint. In the proliferative type clinical evidence of an inflammatory state strongly indicates infection. In the degenerative type some evidence of infection may appear, but the morbid anatomical changes are more of the senile degenerative form. The senility may be premature or physiologically induced by strains of hard labor, poor living conditions, endocrin changes of middle age, or it actually may be associated with the arterio-sclerosis and high blood pressure of the aged.

In the proliferative type there is a proliferation of connective tissue of the synovial membrane. At the same time the bone marrow cells beneath the cartilage become swollen and granulation tissue begins to penetrate the cartilage from below. Pannus of granulation tissue covers the surfaces of the cartilage, so that, as the process of erosion develops from both surfaces of the cartilage, there is a proliferation of fibrous and bone tissue together with atrophy of neighboring bony structures, with the result that fibrous or bony ankylosis occurs.

In the degenerative type, bony ankylosis is the exception. The cartilage may become eroded so that the bony layers on each side of the joint may come in contact, but there is eburnation and increased bone density instead of erosion and atrophy. Secondary changes in the degenerative type consist of activity of the perichondrium at the periphery of the joint where the capsule and cartilage come together, the result of which is a new formation of cartilage and bone. Thus we have the cartilaginous nodes of Heberden on the fingers and the lipping or exostosi on the borders of such joints as the knee, hip or spine. These exostosi indicate some form of progressive arthritic process. They may be quiescent but easily stimulated into activity. Often it is some comparatively trivial injury which causes the flare up.

Etiological Distinction

Etiological distinction cannot be so clearly divided as pathological differences. Similar causative agents may produce primary changes either in the synovial membrane or in the cartilage. It is more common, however, for primary proliferation of the syno-

vial membrane to be induced by suppurative or non-suppurative infections. The causes of cartilage degeneration more often are of a metabolic, toxic, traumatic or focal, non-suppurative, infectious nature.

There are two modes of infectious activity in the chronic undifferentiated type.

1. Direct bacteriological implantations.
2. Allergic or sensitivity reaction.

Infectious evidence. Cecil, Burbank and others have demonstrated that the streptococcus of the hemolytic type is more frequently the agent in proliferative types of arthritis, while the viridans variety is more common in the degenerative types. It is pointed out that these germs inhabit the focal lymph glandular areas and play a harmless role until activated by lowered resistance of the body, or other disturbances. Recent bacteriological experiments prove what long has been surmised, that bacteria may greatly change their form and characteristics to meet their environmental requirements. They, therefore, may become strictly pathogenic in nature when their environment is affected by mouth secretions, emotions, digestion, climate or other such factors.

Allergic evidence. Allison and Ghormley, Small, Zinser and others point out that bacterial agents may be either directly or indirectly responsible in rheumatic diseases. That is, the joint may be infected so as to produce a more acute pyogenic picture or there may be a typical subacute or chronic arthritic picture produced through an allergic reaction in the joint due to special cell sensitivity. According to Allison and Ghormley, this is, in many cases, due to the absorbed products of an active focus of infection, such as a tooth, tonsil or prostate.

Shands and others frequently have found organisms in the joint fluid; Cecil in the blood. However, this does not imply that there is not an allergic sensitivity distinct in form, from the type of joint directly infected with the organism.

Anatomical and Physiological Significance of the Parts Affected

The proliferative type of the undifferentiated class includes a very wide range of rheumatic manifestations. Since the causative agents of this type seem to have a predilection for fibrous tissue, they may pro-

duce changes in the ligaments, nerves, bursae, tendon sheaths and muscles, characterized by varying degrees of inflammatory intensity. Thus given a rheumatic state, the slightest circumstance of trivial muscular effort or temporary assumption of a strained position may evoke a phenomena, the intensity of which is far beyond the assumed cause. Some unusual activity or strain may set up symptoms of pain and disability entirely out of proportion to the severity of the accident. Actual ligamentous tearing may or may not be present, but undoubtedly such sensitiveness on the part of the fibromuscular tissues seem to indicate that there is a pre-existing, unstable condition, probably due to allergic sensitivity or a subinfection of the interstitial fibrous tissue. Lewellyn and Jones explain that in the traumatic lumbago type, a hyper-irritable state of the muscle exists, and when contraction of the muscle exceeds the limits of this pathological hypertonus, a spastic, congestive condition of the muscle results. The unaffected antagonistic muscles immediately resist action because of pain; continuous inhibition of action results in chronic venous stasis and the lymph flow is impaired. Chronic fibrositis, and inelastic scar tissue often are the explanation of continued disability.

Clinical Recognition of the Two Types

The two pathological types must be chiefly diagnosed through clinical, laboratory and x-ray evidence. The secondary changes produced by broken down tissue, loose bodies and other irritants may greatly mask their distinction.

By placing the clinical forms in the pathological classification, prognosis as to permanent disability may be more accurate and treatment more appropriately applied. This is becoming more obvious in these days of economical surveys and industrial organization. Men of labor, strong and rugged, often neglect their general hygiene and diet, and when exposed to undue trauma, or occupational strain, become a burden rather than an asset to society.

The proliferative type may be recognized through any of the following clinical pictures:

1. Mono or multi-articular joint involve-

ment with varying distention of joint capsule.

2. Periarticular ligamentous involvement, such as is commonly found in the shoulder or knee.

3. The neuritis form as in sciatica.

4. The bursal affections such as in subdeltoid or os calcis bursitis.

5. The lumbago and torticollis affections of the muscles.

6. The teno-synovitis conditions.

In the degenerative type the following clinical forms predominate:

1. Mildly painful fingers with Heberden's nodes.

2. The dry, non-swollen knee and hip joints, with marked crepitation, but comparatively little disability.

3. Osteoarthritis of the spine, with the slow progressive mildly disabling bone liping proliferation.

4. Senile arthritic changes normally appearing from the age of 45 to old age.

5. Menopause, arthritic syndrome involving chiefly the knees.

6. Monarticular phenomena known as "morbus coxae senilis."

7. Metabolic disorders of gouty, or endocrine nature.

8. Neuro-trophic disorders of syringomyelia, hemophilia and tabes dorsalis.

In the degenerative type one of the most frequent clinical phenomena is that of osteoarthritic changes of the spine. From the economic standpoint the osteophytes of the vertebral borders often provide an excuse for litigation and unjust awards of compensation. This type is not so often caused directly by bacterial invasion. Probably it is a long continuous resistance against static affections in which the resistance to infection is overwhelmed, due to lowered vitality as in colon stasis, the menopause state or nervous disorders.

The patient often is not aware of the creeping upon him of arthritic changes. He may appear robust or obese, but metabolism may be slowed down or blood pressure low.

Roentgenological evidence. In the active stage of the proliferative type of joint affection, the x-ray often shows atrophy of the subarticular structure, cloudiness of the joint, narrowing of the joint space, indicating destroyed cartilage and bone atrophy.

Later, as the repair process takes place the synovial distention disappears, the cartilage and ligaments present new bone proliferation and ankylosis. In the degenerative form the x-ray will show lipping and hypertrophic bone growth out of proportion to the loss of function. The subarticular bone tissue will show increased bone density instead of atrophy. Ordinarily there is no synovial distention, although trauma from loose bodies may produce increased synovial fluid. Ankylosis may be present but it is of a mechanical nature due to blocking of movement by the hypertrophic bone growths.

Significance of Diagnosis in Treatment

It is through failure to apply thoroughness in the early stages that the case arrives at the office of the orthopedic surgeon, a cripple.

Dependence solely upon removal of focal infection after multiple tissues have become chronically affected leave the patient subject to eventual invalidism.

When the pathological and etiological characteristics of this disease are understood, therapeutic measures become more comprehensive. The following points therefore, are significant in respect to treatment:

In the *proliferative* type:

1. Infection usually is plainly discernible because of the inflammatory nature.
2. Deformity often occurs in short time.
3. There is a distinct tendency to bony ankylosis.
4. Bone atrophy often becomes severe.
5. The general health is rapidly affected.
6. Pain and physical incapacity is severe and persistent.
7. The carbohydrate tolerance is diminished. Sometimes there is an increase in blood sugar.
8. Fibrous or soft tissues often are affected.

In the *degenerative* type:

1. Infection is not so prominently active.
2. Joints become mishapen, but bony ankylosis is not so likely.
3. Static effect of gravity in weight bearing and wear of strain increases the pathology.
4. General health may appear to be excellent.
5. Pain consists of tenderness, not of inflammatory type.

6. There are signs of senility, premature or natural.

7. Metabolism may be greatly disturbed. Obesity may be marked.

8. Endocrines often are at fault, especially at the menopause.

Important Therapeutic Measures Consistent With These Features

1. In the proliferative type, the source of infection and its invasion of the tissues must be given intensive study. An attempt must be made to increase the immunity and decrease the sensitivity of the body cells for the infective organism which usually is a strain of *streptococcus hemolyticus*. Foreign proteins and non-specific serums are not so effective for this type as are the autogenous and the specific stock vaccines, providing the latter are employed according to the recently established methods of Burbank, Cecil, Small and others.

In the degenerative type, infection often is a remote influence on the progressiveness of the morbid changes, but it is more insidious and less acute. It often points to intestinal stasis or generally lowered resistance as the source of its activity. Vaccines of the *streptococcus viridans* strain, foreign proteins and non-specific serums often are effective.

2. In the proliferative type, orthopedic measures must be applied to prevent deformity. Motion must be preserved if possible, because of the tendency to bony ankylosis. On account of the inflammatory nature of the disease, forcible motion is contra-indicated in the active stages. Added trauma in any stage further may induce ankylosis.

In the degenerative type, the joints must be relieved of stress of gravity, weight bearing and wear. The deformity is due to impinging bony or fibrous growths so that the joints must be kept active, yet protected from the irritation of undue strain.

3. Physical therapy measures, especially, must be carried out according to indications of the type of case at hand.

In the proliferative type, treatment of the inflammation, congestion and pain of the early stages must differ greatly from that of the atrophy, fibrosis, and stiffness of the later stages. Irritative measures will increase inflammation and pain in the acute

or subacute stages. Heat, local or general, will increase elimination and assist in alkalinizing the blood. Local applications should be sedative or counter-irritants. In the later stages, stimulation of circulation and nutrition is indicated. Local heat is effective. Massage is extremely useful and graduated medical gymnastics are essential. Properly applied, these measures will promote acidity and metabolic balance, overcome atrophy and hasten return of function.

In the degenerative form, hydro-therapy, colonic hygiene or other measures which increase elimination and promote improvement of body metabolism are important. Stimulation locally of peristalsis, actinic tonic radiation to the skin and absorptive applications to the parts actively involved, may be accomplished by physical therapy. Massage and exercise are important in that they produce absorption locally of toxic and regenerative products.

4. Drugs seemingly are decreasing in popularity because of the greater dependence upon elimination of the causative factors. Sodium salicylate still is a popular prescription but its indications are lessening as progress is made in histological and physiological investigations. Pain must be relieved. Some of the newer preparations, such as amiodoxyl or oxybenzoate are effective in abating the discomfort and inflammatory exacerbations of the acute or subacute stages of the proliferative type. Such drugs as iron and arsenic may be strongly indicated in the proliferative type because of anemia and other general impairment.

5. Diet is an extremely important feature in both types. In the proliferative form it is often very necessary to combat general deviation by a nutritive diet.

In the degenerative form it is often necessary to reduce the food intake. Pemberton has stressed the low carbohydrate diet in both types. Hypothyroidism and lowered metabolic rate are found more often in the proliferative type.

Summary

1. It is well established that there are two fundamental pathological types of rheumatic disease. The terms best suited to these types are those of proliferative and degenerative.

2. In order to make an accurate diagnosis of these two types, clinical, x-ray and laboratory characteristics should be studied.

3. The purpose of diagnosis is to appropriate treatment to the characteristic nature of each type.

Discussion

Dr. Luther A. Tarbell (New Haven, Conn.): I would like to ask the essayist one question, and that is, if he finds in some certain cases that heat seems to be definitely contraindicated as we find some cases in which it seems to aggravate the condition rather than help it?

I think the matter which he brought out which we have to do, of course, in all cases of arthritis is, first, find the cause, do everything we possibly can to eliminate various foci, which sometimes is a very painstaking process. I do think another factor which is very important sometimes in some of those cases and which adds to their tribulations is the matter of thorough elimination. I think sometimes in the matter of the condition of the colon, especially where they have lots of a bad type of bacteria aggravated by constipation, those conditions are very much worse. It seems to me that our elimination can be of great value.

I would also like to ask the speaker for his opinion or experience with intravenous medication, such as sodium iodid or sodium salicylate, or perhaps various mixtures of some of these kinds which are so common on the market at the present time.

Dr. Earl D. McBride (Oklahoma City, Okla.): In answer to the doctor's question in regard to heat, I think there are many times when heat is contraindicated, but you have to select your heat to suit the case. If there is any tendency to inflammatory signs, such as you see about the knee joint occasionally or an elbow joint, the heat must be very sedative, given very moderately, even in the acute cases, that is true.

The intravenous drugs, I think, are only useful in respect to temporary relief. Amiodoxyl and similar preparations given intravenously have given us considerable comfort in respect to certain types of patients where we wished to get quick relief, to gain the patient's confidence that something could be done for their relief and then go ahead with other measures such as the use of our vaccines or of eliminating focal infections.

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ATROPHIC RHINITIS

REPORT OF A CASE TREATED BY NEGATIVE GALVANISM AND POTASSIUM IODIDE

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The following is a case report of a male patient seventy years of age, who gave a history of having suffered from atrophic rhinitis for a period of about twenty years.

His general examination showed the usual changes attendant upon age; his blood Wassermann was negative.

Examination of his nasal passages revealed extreme atrophy of the turbinates and mucous membranes of the nose. The turbinates were heavily crusted with inspissated, foul smelling, purulent secretion.

Treatment: For many years he had used irrigation and various applications for what relief they could give. When negative galvanism with potassium iodide was decided upon, his nasal passages were thoroughly cleansed with forceps and irrigations; the cavities were then packed with cotton soaked in 1 per cent potassium iodide; care was taken to have the iodide soaked cotton in close contact with the turbinates. The cotton was then connected

with the negative pole of the galvanic apparatus, the positive pole being attached to the arm on the same side as the nostril being treated. Ten milliamperes for ten minutes were given to each nostril at one sitting.

After the first treatment the mucus membranes remained practically free of purulent secretion for one week. The treatments were repeated twice more at weekly intervals with the same results. The patient then passed out of observation (July, 1930) and the effects of further treatment could not be observed.

The negative pole of the galvanic apparatus was used in an effort to drive the iodine ion (negative ion, anion) into the tissues, and to cause dilatation of the blood vessels.

It is difficult to predict what the outcome of the condition would have been if the treatment could have been continued; but the results obtained in the limited period would seem to justify a further trial of this method of treatment for this intractable condition.



FACTORS DETERMINING THE CLINICAL RESPONSE TO ULTRAVIOLET RADIATION *

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As an introduction to the discussion of this subject, I wish to point out that the mere fact that we are obliged to consider the exposure of the body surface to ultraviolet radiation as a means of correcting morbid conditions, is in itself a rather pathetic indictment against our much-boasted modern civilization. With a force so readily available and so generously bestowed as sunlight and one that is so obviously beneficial, it would seem that the person must be thoughtless indeed, who would neglect to make use of it to such a degree that he not only becomes ill because of this neglect, but his physician is compelled to provide artificial sources of ultraviolet radiation and often to exercise his utmost persuasive powers to prevail upon him to make use of it. It is true that there are many difficulties in the way of applying our knowledge of the benefits of exposing the nude body to natural sunlight and many advantages in the use of artificial sources, but these, at least, can hardly excuse such a widespread indifference to them as to result in their almost universal neglect and the enormous prevalence of impaired nutrition and functional efficiency that can be traced directly to this cause.

In view of the extensive studies that have been made both experimentally and clinically in the effects of these frequencies of radiant energy on the human economy and the results that have followed their therapeutic application, we have no apology to make nor can we be dubbed faddists when we insist that their periodic use is essential to complete well-being and the prevention of disease.

In fact, we can go farther than this and assert that there are certain definite signs and symptoms by which it is possible to diagnose the existence of a deficiency condition which is directly traceable to a lack of ultraviolet radiation and is quickly and

positively corrected by its use. Unfortunately, this diagnosis is often complicated by the fact that these same signs and symptoms may result from other associated causes, and unless these are recognized and removed the improvement that we have been lead to expect from ultraviolet treatment does not follow. Even rickets which has been so closely identified with vitamin D deficiency presents many variations and involves a number of predisposing causes.

As one instance of this, there is the observation pointed out by Moore⁽¹⁾ that in experiments upon animals it frequently requires three generations to produce rickets by dietary deficiency in a strain of animals previously free from the disease. Once the defect has become established, however, the off-spring readily exhibit the effects of a deficiency diet. Clinical experience, also, indicates that we frequently have to deal with an inherited rachitic diathesis. The frequent association of cretinism with rickets and other evidences of thyroid dysfunction is additional reason for concluding that other causes are involved than a simple vitamin D deficiency.

These facts help to confirm the opinion which is gaining wider support, that vitamin D activation is only of secondary importance in accounting for the effect of ultraviolet radiation on calcium and phosphorus metabolism and no amount of vitamin feeding can quite take its place.⁽²⁾

Reconstructive Action in Deficiency Disease

While the difficulty in determining the precise nature of the disorders is not so serious in respect to the treatment of rickets with ultraviolet radiation, it becomes more of a consideration in the management of other clinical conditions in which ultraviolet frequently proves an effective means of treatment. We need only mention a few of these such as tuberculosis, eczema, acne, and peptic ulcer to emphasize the gravity of the problem.

In tuberculosis, we are not only dealing

* Read at the Tenth Annual Meeting of the American Congress of Physical Therapy, Omaha, Nebraska, October 6, 1931.

with a nutritional deficiency but we have the situation complicated by the existence of an infection with greater or less degree of tissue destruction. As I pointed out three years ago in my paper on "Focal Reactions to Ultraviolet," the improvement in resistance that follows radiation with ultraviolet often results in an increase in toxic symptoms that masks the beneficial effect. Under these circumstances, the clinical response will naturally show considerable variation from that observed in non-tubercular patients.

Disappointing results in the treatment of eczema may sometimes be accounted for by the difficulty in always differentiating the eruption associated with a true dyscrasia from that caused by a parasitic infection or, in some instances, when one is superimposed upon another. A suggestion that I first heard made by Lynn Green, of Kansas City, has often proved helpful in diagnosing these lesions. He points out that an eruption due to a systemic condition is invariably symmetrical, while those resulting from a direct infection of the skin are likely to be confined to one extremity or to one side of the body or face. The manner of onset and spreading is also important.

As demonstrated by Halld-Davis,⁽³⁾ a high blood sugar is frequently found in these eczema cases. For this reason, the results with light therapy may be subject to correction of the patient's dietary, although, in some instances at least, the high sugar tolerance may be taken as a manifestation of the disordered metabolism that is responsible for the eruption.⁽⁴⁾

We find this same susceptibility to carbohydrates in many cases of acne. Restriction of these elements in the diet constitutes the main feature of its treatment with some dermatologists. It has been my observation, however, that acne patients, as in some forms of obesity, have strong craving for sweets and are likely to experience a certain degree of discomfort and lassitude if the diet is too restricted. Ultraviolet radiation not only through its action on the infecting organisms in the sebaceous glands and the improvement in the resistance of the tissues exposed to the rays, but by its correcting effect on the general nutrition, becomes the most reliable measure in the

treatment of this disease. However, the results are greatly influenced by the proper combination of other measures, especially infrared radiation and massage.

Importance of Proper Diagnosis

As valuable as the actinic rays are when employed for their reconstructive action on the processes of nutrition and oxidation, they can not be looked upon as a panacea or as an antidote to slovenly diagnosis. Although we have found it useful in overcoming certain digestive disorders, increasing the appetite and toning up the musculature, we are still sufficiently conservative in our estimate of its merits to believe that when we have definite evidence of a chronic appendicitis and lesions of a like nature, they should be dealt with in a surgical manner.

Sometime ago, in a paper on "The Signs and Symptoms of Vitamin Deficiency and Their Relation to Ultraviolet Therapy,"⁽⁵⁾ I attempted to describe some of the clinical symptoms in adults that can be definitely attributed to a lack of ultraviolet radiation and vitamin deficiency, which can be accepted as a guide to the probable results that can be achieved with treatment. The symptoms were classified as follows:

1. Increased sensitivity to cold and sudden changes of temperature.
2. Disorders of endocrine function.
3. Digestive disturbances without organic lesions.
4. Migratory pains.

This list does not include all the symptoms that can be attributed to a lack of ultraviolet. Its purpose is to select those that are most characteristic of this condition and that respond readily to light treatment. Increased fatigability and loss of muscular tone might be included as most characteristic features of light starvation, but, unfortunately, they are present so often from other causes that they have little value as diagnostic symptoms. Loss of weight, decreased resistance to infection and in some degree, allergic sensitization, are other symptoms that may be greatly influenced by light radiation, but they, likewise, have little diagnostic value. Sooner or later, whenever clinical conditions in which these symptoms predominate are discussed, the term, acidosis, is certain to be included.

Acidosis has been defined as "a state of

depletion of the alkali reserve." It manifests itself objectively by an increased acidity of the urine. As Fischer has shown, however, acidosis may exist with very little variation in the hydrogen-ion content of the urine.⁽⁶⁾ While many of the disturbances of function in acidosis can be neutralized and counteracted by the judicious administration of alkalies, such treatment does not eliminate the primary cause for the accumulation of acid bodies in the tissues. Under normal conditions the acid products of metabolism are completely oxidized into inorganic salts, water and carbon dioxide. Although such acid production amounts to some 44 gms. of carbon dioxide in the twenty-four hours for the average adult, sufficient alkali is always available to neutralize it and maintain an acid-base equilibrium. Even when excessive quantities of acid are introduced into the circulation under experimental conditions, the reaction of the blood is quickly readjusted and returns to normal alkalinity. Under these circumstances, "a depletion of alkali reserve" hardly suffices as an explanation of a pathologically decreased pH index. The ready adaptability of the body chemistry to increased acid production is also illustrated by the rapid neutralization of the great increase in carbon dioxide production that takes place during violent exercise.

It is not our purpose here to attempt a full discussion of the causes and effect of changes in the balance of electro-positive and electro-negative elements in the body fluids. We merely emphasize these points because we feel that the widespread notion that this is just a matter of making sufficient alkali available, results in a great amount of mischief through a failure to appreciate and correctly treat the underlying cause.

The primary cause of acidosis is the accumulation of the unreduced, split products of protein and fat metabolism in the tissues. Such incomplete reactions may take place either as the result of a lack of oxygen or because of the absence of certain catalysts and oxydases that serve to energize this reduction process. In either event, lactic acid, acetone, di-acetic acid, methyl guanidine, and perhaps even more complex electro-negative and highly toxic ions accumulate

in the tissues and blood stream. Such a state of sub-oxidation may involve the entire organism or it may be confined to a local part. Recent studies on acidosis in tuberculosis have shown that there is an unquestionable relationship between oxygen deficiency in the blood and the appearance of lactic acid therein.⁽⁷⁾

Oxidizing Effect of Ultraviolet

One of the outstanding properties of the Dorno band of ultraviolet is its profound influence on the molecular structure of oxygen. That this property serves to account for many of the effects produced on the human organism, is quite apparent from an analysis of many of the observed experimental and clinical changes that are associated with exposure to these rays. Unfortunately, we can not at this time discuss the nature of these effects more fully. I can only state that continued observation and study of the action of ultraviolet on organic function has established a growing conviction that practically all the effects of these rays, even including vitamin activation and its effects, can be explained as the result of improved oxidation.

Among the clinical conditions in which acidosis is a large factor in the production of symptoms, diabetes mellitus is the most familiar. Because of the tendency to acidosis and the probable vitamin deficiency that can readily occur with a too restricted diet, it would seem that ultraviolet radiation would be especially indicated in this disease. Nevertheless, the statement has repeatedly been made by various observers that ultraviolet is contra-indicated in diabetes. On the other hand, Kerr Russell, of England, has observed a reduced glycosuria and symptomatic improvement under heliotherapy in an advanced case.⁽⁸⁾ Frankel-Tissot⁽⁹⁾ states that in high mountain altitudes both hyperglycemia and hypoglycemia tend to a more normal level under ultraviolet radiation. It is possible that some of this prejudice against the use of ultraviolet in diabetes may be accounted for by the fact that diabetics are likely to be photo-sensitive. I have used it in a few cases with excellent results, one of them a rather advanced case of long-standing, in which a gangrenous toe healed rapidly after local and general ultraviolet radiation was instituted.

Latent Action of Ultraviolet

The close relationship between the action of ultraviolet radiation and vitamin activity permits us to draw certain parallels in the clinical response they evoke. The distinction between immediate and remote effects of ultraviolet is analogous to the slow recovery from vitamin starvation even after ample vitamin is exhibited in the diet. The recovery time varies with the type of deficiency just as a marked difference has been observed in the depletion time of the several types of vitamins. While recovery from a deficiency in the anti-neuritic fraction of vitamin B is fairly rapid, in the case of vitamin A and D it is usually a matter of weeks, and recovery from scurvy may be a matter of months.

It is not uncommon, likewise, to see a more marked change in a patient's condition some months after treatment with ultraviolet has been discontinued than was noticeable at the time the treatment was being applied. The following experience I had with one of my earlier cases impressed me most forcibly with this delayed or, more properly speaking, prolonged effect. A woman of middle age complaining of intractable neuralgic headaches, always tired, a moderate enlargement of the thyroid, was given three general radiations with the Alpine lamp over a period of one week. Marked relief from the headache was reported after the first treatment. She did not return for further treatment, but I encountered her about six months later and I remarked about the great improvement in her appearance. She stated that she had been well ever since she had had the ultraviolet treatment, and her work was not quite as difficult for her as it had been. Such a prolonged and positive improvement from so short a period of treatment is rather exceptional, but our experience has been that just as great benefit results in the general nutrition and functional efficiency by interrupting the treatment after a measurable improvement is apparent, or when the condition becomes more or less stationary, and resuming treatment when signs of relapse begin to appear.

Variation of Skin Sensitivity to Light

Aside from this latent and delayed response, there is still another reason why

the prescribing of ultraviolet radiation in a routine, indiscriminate course of treatment rather than attempting to adapt it to the individual's requirements is unsatisfactory. Even though we have taken into consideration the factors involved in the diagnosis of these nutritional disturbances and the disorders of intermediate metabolism, there still remain certain elusive, individual idiosyncracies that escape analysis and still may have a decisive influence on the character of the clinical response. In some cases light therapy appears to act like magic, so much so that we are lead to wonder, as Gertenberger expresses it, "If we are seeing straight or not." Others, apparently with the same symptoms may find the same treatment disappointing. Some people are extremely sensitive to light. Others tolerate all the skin will absorb without blistering. So far this variation in sensitivity has escaped analysis. My impression has been that the character of the skin reaction bears some relation to capacity of the subject to respond to the effects of ultraviolet in a constructive way. Patients that sun-burn easily and develop a pigmentation of the skin rapidly, are easiest to manage and usually respond well to the treatment. They probably don't need it as much, however, as the more refractory types, because their healthful reaction is evidence in itself of a fairly normal state of metabolism that needs little correction.

This variation in the sensitivity of the skin to light has nothing to do with the natural variation due to differences in complexion. Possibly a difference in the phosphorescence of the epidermis may have something to do with it. Some integuments photograph almost black although they show little pigmentation to the eye. A very slight chemical change such as that of inactive and activated ergosterol is sufficient to bring about decided spectroscopic alterations that could readily account for such variations in erythema reaction. Whatever the explanation may be, we have found this skin reaction of some practical value in forming an opinion as to the capacity of the patient to respond to ultraviolet radiation.

Finally, it must not be forgotten that it is necessary that the diet contain sufficient calcium, phosphorus, and other minerals to

meet the nutritional requirements of the patient. To insure this, we always insist on at least a pint of milk in the diet, whole wheat either as a cereal or in bread, and as liberal supply of fats as the patient's condition will permit. Fats are essential not only as a source of energy, but because they are indispensable to the chemistry of cell function, particularly the white cells, nervous system, and the endocrines.

Conclusion

To summarize these observations, we may classify the factors that determine the character of the clinical response to ultraviolet radiation into four groups, as follows:

1. The degree of vitamin deficiency present.
2. The degree of sub-oxidation, acidosis, and functional disorders that may exist.
3. The severity of organic lesions and infections that may be associated with the former.
4. Individual idiosyncrasies of body chemistry, inherited and acquired, photosensitization, allergy, endocrine balance.
5. Adequate supply of minerals in a diet that is regulated according to the individual needs of the patient.

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Discussion

Dr. M. F. Behneman (San Francisco, Calif.): As Dr. Warnshuis has pointed out, the diagnosis of ultraviolet deficiency in the human body is

often complicated by other factors. A fair analysis of its value must likewise be a complex affair. This complication is due chiefly to the fact that such changes are chemical in nature, recognizable not by clinical judgment alone, but by extensive laboratory investigation, such as Dr. Levine discussed yesterday.

It is true that we are justified in using empirically a therapy of value to the patient, but in summarizing its beneficial results we must not let enthusiasm outpace exactitude.

In our enthusiasm we are prone to practice a method of judgment used many years ago, that of ascribing certain results to a form of therapy which we unwittingly have combined with others and seem to disregard the others. If no other therapy except ultraviolet is used in an individual case, then we have a right to sum up its benefits, but most of us combine such treatment with a new or changed diet, more rest or more exercise, glandular or chemical therapy, and many other things, which in themselves produce a new chemical reaction and play a large part in aiding ultraviolet to do its part in recovery.

The whole solution to the benefits of ultraviolet radiation undoubtedly lies and will lie further in increased oxidation. Our knowledge of colloidal chemistry is really in its infancy, but in this field alone I feel we will find the solution to the benefits of ultraviolet radiation.

While it is true that clinical improvement always justifies the continued use of a rational therapy, nevertheless it won't be rational medicine until proof comes to us from a recognized laboratory investigation. We know, from excellent researches on such work, for instance, that the following factors also play a part in the clinical response to ultraviolet radiation:

We know that the chromophores of the skin are irritable and sensitive to ultraviolet light, and that the amount of cholesterol plays a major role. We know that an excess of salts in the aqueous humor of the eye produces opacities of the lens in a dosage of ultraviolet that would not affect a normal eye. We know that neurasthenic people react well to ultraviolet stimulation, probably due to sympathetic nervous system action.

We know that tropical temperatures increase the red cells of the blood at least ten per cent, even if there is no exposure to the sun, a fact which has often been overlooked, and ascribed to ultraviolet, which was a little unfair to the other factors. We know that normal blood pressure is not changed, but that high blood pressure can be made lower by ultraviolet radiation. By that I mean not changed permanently over any length of time. Blood sugar tends to become normal, if it is abnormal. In the basal metabolic rate, we know that the temperature of the air and even minor external factors influence blood pressure far more than ultraviolet radiation. It has been proved often that altitude and climate regulate red cell and hemoglobin formation more than ultraviolet radiation alone.

The amount of the body exposed and the area exposed is a strong factor in clinical response to

light. The kind and severity of the illness and even the hour of the day play a part. And lastly of all, a rapid growing organism needs more ultraviolet than a mature one and it takes more to produce an effect.

These things we know from laboratory proof. Dr. Warshuis has outlined factors which he knows from personal observation and other workers. The chemical solution of these many phenomena will undoubtedly prove a complex problem and the solution will come only when we know the life of the individual cell.

Dr. J. S. Hibben (Pasadena, Calif.): We who are using Physical Therapy as an adjunct in our practice realize that our medical colleagues are watching, ready to criticize us if we use an energy without knowing fully the physical and chemical actions provoked by its use, when they, as well as some of us use all manner of drugs empirically. We frankly plead the same justification since our intentions are as honest as the advancements of science has permitted.

For many hundred years Japanese were accustomed to public nude bathing and sun exposure of both sexes. Now modern civilization and christian puritanism have decreed that they must wear clothes. Morals are now more tolerantly exercised and we are reverting in part to their old custom, with our fads of bare heads, scant beach and civilian attire. In fact, in 25 years, female attire has decreased from 15 lbs. in weight to 3½ lbs.—half of that shoes.

I have observed in some of my patients who spend the summer at the seashore, practically living in their bathing suits and developing an extensive tan, that they seem to have more immunity against disease than those that stayed at home.

Rickets in Southern California is not a problem, due to our sunshine, out-of-door life, and fresh vegetables and fruits. The cases of rickets and asthenic, undernourished individuals apparently suffer from an inability to metabolize these products rich in health producing properties. And often ultraviolet from an artificial source acts as the catalyte that sets off the spark. Simakula, Sonne and Reckling, Marshal and Kunsdor; Steinbach, Fosbinder and Daniels have shown that wave lengths between 2200 and 2800 A. U. are more active than frequencies between 2900 and 3160 A. U. in the activation of vitamine D, and I prefer and use these frequencies in this type of case.

When we use, or recommend, ultraviolet irradiation we presuppose that the associated causes have at least been taken into consideration and coincident effort made to combat them.

In the use of ultraviolet irradiations upon the human organism we have the following conditions and sets of effects that are relatively distinct and to be desired:

1. Local effect of cell destruction.
2. Systemic effect of vitamine activation and of cell stimulation, and not of cell destruction.
3. We must also take into account the relation

of ultraviolet energy distribution as used for the systemic effect.

4. Energy density of discharges from artificial sources of ultraviolet radiation in relation to

(a) Duration of time.

(b) Extent of space as applied to the human body as a whole.

Taking into account these facts we can more intelligently use ultraviolet irradiations on our patients.

I am glad Dr. Warnshuis brought out the point that improvement in the patient is often seen weeks after treatment with ultraviolet irradiations which also has been my observation. We irradiate with ultraviolet most of our post-operative surgical cases and have found that convalescence is markedly shortened. So important do I feel this is that we make no additional charge to our patients for this service.

The recent work of Dr. I. M. Rabinowitch, of the Montreal General Hospital, indicates the probability that the cause of the glycosuria in diabetes is due to a digestive enzyme in the blood which destroys to a greater or less extent the insulin content, rather than the failure of the pancreas to secrete the necessary amount to hold the blood sugar at normal. This opens up an entirely new angle of attack for the alleviation and possibly for the cure of diabetes. In this connection it is interesting to note that in the conflicting reports as to results of irradiation by ultraviolet in diabetic cases, marked improvement has been reported by different observers. It is perhaps especially suggestive that reactions similar to those characteristic of insulin shock have been observed. Might it not be that irradiation may be found helpful in retarding the activity of Dr. Rabinowitch's insulin-destroying digestive enzyme? The answer, of course, awaits further experimental study.

Prof. A. Bachem (Chicago, Illinois): I consider myself as fortunate in listening to an interesting paper like the one of Dr. Warnshuis and to the interesting discussions, and I should like to use this occasion to get some more information from an authority like Dr. Warshuis.

Dr. Warnshuis told us many interesting things about oxidation. Oxidation surely plays a very important role in the effect of ultraviolet. I remember that some German workers followed up this question of oxidation, but also of reduction. They came to a rather clean-cut conclusion. How correct it is I do not know. In fact, I do not believe conditions are as simple as they pronounce them. They claim that a certain area of ultraviolet produces oxidation, but with longer waves, the ultraviolet still invisible, reduction is favored. This would be of great importance to the upholding or improving of the pH gradient of the skin, because the far ultraviolet is more absorbing in the upper layers and the near ultraviolet penetrates a good deal deeper. It would be interesting to see how the pH gradient would be improved by oxidizing reducing effects.

I wonder whether Dr. Warnshuis can tell us

a little more about this or give us his own point of view on it.

It seems to me that the question of oxidation plays an important role, or may play a certain role in the cancer problem, because we know about the different grades of oxidation and the lactic acid production in relation to cancer, and to prove its relationship to the question of oxidation might help us a good deal in this respect.

So far as sensitivity to ultraviolet is concerned, I must say that this is my favorite subject at the present time. I am working on the following, namely: How much sensitivity to ultraviolet is produced by the thickness of the horny layer, by the thickness of the malpighian layers, and by the status of the vegetative nervous system, because it seems to me that these are some of the important items if not the most important ones.

In regard to reactivity, Dr. Marshall's accepted standpoint is that root reactivity is a good diagnostic sign for recovery. On the other side, I remember that Petersen and other German authorities now incline toward the other side, namely, they suggest after a certain amount of pigmentation is produced to wait for a variable length of time in order to permit a greater sensitivity to be established before further ultraviolet treatments.

There is only one item that I might have to criticize, namely, I still feel that acne reacts more to x-ray than to ultraviolet treatment, and I still consider the x-ray treatment of acne as the treatment of choice. In fact, in the dermatological department of the University of Illinois, we get wonderful results with acne on account of the allergic effects on the skin, and we only apply ultraviolet after x-ray has been applied. That is, we would rather go over to another kind of treatment that might prove less harmful than a too large accumulation of x-ray energy.

I would appreciate to hear Dr. Warnshuis' views about oxidation and reduction, and perhaps how it is produced by ultraviolet.

Dr. F. W. Nelson (Ottumwa, Iowa): I should like to ask Dr. Warnshuis, for the benefit of some of us ordinary clinicians, what benefit he gets in so-called athletic foot from ultraviolet rays or the Kromayer lamp, and also in impetigo?

Dr. J. U. Giesy (Salt Lake City, Utah): Referring again to the subject of oxidation, I should like to ask Dr. Warnshuis if there may not be a possibility of what amounts to a protein stimulation of oxidation, not by a foreign protein but by the effect of the ultraviolet rays upon the integral biochemistry of the skin cell.

I mean there is a sufficient change produced in the protoplasmic content of the cell to cause a certain autoproduct absorption which stimulates the oxidation.

Dr. N. H. Polmer (New Orleans, La.): While speaking of oxidation and the status of the patient's cell in cancer, I should like to call your attention to an excerpt from last Sunday's Chicago Tribune, giving a report to the United Press of the research of Dr. E. McDonald, Director of the Cancer Research Laboratories,

Graduate School of Medicine, University of Pennsylvania. This is what Dr. McDonald found: "In normal cells half of the absorbed glycogen is oxidized and half turned into lactic acid. In cancerous cells, for every thirteen glycogen molecules twelve are split up into lactic acid and only one is oxidized."

In his search for some form of therapy which will be more effective in the treatment of cancer, he asked for an agent which will do four things:

1. Normalize the breaking up of the body sugar.
2. Normalize the blood alkaline state.
3. Reduce high blood sugar, which he has found in cancer patients.
4. Increase the cell's calcium and reduce the cell's potassium.

He found that there was an increase of potassium and a body loss of calcium.

It seems that we may be working along the right lines in stressing these problems and their bearing and response to ultraviolet radiation. Certainly we should like to hear more about it.

Dr. G. J. Warshuis (Cedarburg, Wis.): This discussion has grown out so that it almost seems as though the paper has become the tail of the kite, and to attempt to discuss the many and important points that were brought up in the discussion, I am afraid, would be a rather long drawn out and tedious proposition at this time.

I was very glad to have Dr. Behneman's observations on some of the factors that would influence a clinical response that were not included among those I discussed, and some of these factors he mentioned certainly are not to be ignored.

In a paper of this kind, of course, it would be impossible to attempt anything like a comprehensive discussion of all the elements that enter into this problem. I merely attempted to select those factors that in my own clinical experience have proved helpful in trying to give a patient an estimate as to just about what he could expect in the way of improvement from that sort of treatment, and, of course, in predicating those results we have to take into consideration the other elements in the treatment that naturally follows.

It is possible, however, to come to some conclusion as to how important the ultraviolet is in attaining the desired results by comparing cases in which these other measures are used without the addition of ultraviolet with those cases in which other supportive measures are used and ultraviolet is used in addition. While it would require a pretty large series of cases perhaps to come to definite conclusions as to just how important the ultraviolet is in obtaining those results, nevertheless when you see two fairly similar cases and one responds in a most remarkable way as compared with the other, I think those impressions are of scientific value. I think there has been a tendency, altogether too much, to rely on the statistical, the inductive method of arriving at our conclusions as to the value of

this or that measure, and not enough on our own natural powers of analysis.

The question of whether the action of ultraviolet is an oxidizing or reduction action, as Dr. Bachem mentioned, I would answer by saying it is both, as paradoxical as that may seem. The point is that both in your reduction and in your oxidizing reaction, in both instances, we have to do with the inner change of the oxygen element and the breaking down of your complex protein molecule into the simple products of carbon dioxide and so forth. This takes place largely by a process of reduction.

The breaking down, for example of creatinin, which is quite a toxic substance and only occurs in increased amounts and is very seldom found except under pathological conditions, into creatin is a very simple reduction reaction. The difference between the two is determined by the mere difference in a molecule of water.

On the other hand, when these substances are reduced to their more simple form, the addition of oxygen again will make them more soluble and readily excreted. Of course, by these oxidation processes the electro negative balance is naturally increased, and it would seem we are adding to the acidosis rather than decreasing it. It must be remembered, however, there is a difference between an acid compound which does not readily diffuse through your cell membrane and an acid compound like carbondioxide which is readily eliminated in the lungs.

I do not know if that answers the question exactly, Dr. Bachem, but I think if you will analyze the process a little bit you will agree that we are justified in speaking of this process of catabolic metabolism as being both an oxidation and a reduction process.

In regard to the comparative merits of ultraviolet and x-ray in acne, that probably is largely a matter with which modality one is most familiar. I quite agree that the x-ray has given splendid results, but the reason I rather lean toward ultra-

violet is that I feel we have an underlying dyscrasia in acne, especially when you consider how commonly that is found in the adolescent period of life, and the ultraviolet would have a tendency to correct this dyscrasia more than the x-ray. The x-ray may be more effective in the immediate effect on the infection in the skin itself, but by using ultraviolet we are correcting the dyscrasia, and it would seem as though there is less likelihood to relapse, and recurrence will not take place so soon after ultraviolet treatment as it does after x-ray.

I have seen good results from the use of ultraviolet with the water-cooled lamp under compression in athlete's foot. There are other simple germicides, however, topical applications that have proved equally efficient. It is certainly a much simpler method of treatment, but you can cure it with the water-cooled lamp.

The point that the doctor brought out about the possible effect of the systemic action of ultraviolet to a protein sensitization is well established by experimental studies. DeGrouer has shown, for instance, in the study of the effect of ultraviolet on the Schick test, that use of diphtheria toxin following up the ultraviolet radiation acts very much the same as when the diphtheria toxin antitoxin is used. In other words, it substitutes to a certain degree for the antitoxin.

There are a good many features about the clinical effects that we see from ultraviolet which correspond closely to your conception of the reactions that take place as a result of colloidal shock or the injection of foreign proteins. There is no question but a certain amount of protein disintegration takes place in the skin, in the epidermal cells of the skin, under the action of these rays and sufficient of this can be absorbed to produce a foreign protein reaction. I know there are many other points about this discussion that I perhaps have passed over, not because they are not important but it is rather difficult to take up all those points in an extemporaneous manner.



DIATHERMY *

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Diathermy is the application of the bi-terminal high frequency d'Arsonval current to the tissues. It produces, with opposed electrodes, a through and through pathway of heat. It is perhaps the most valuable single agent used in therapeutics. So many are its indications that, when named individually, they form an imposing list of pathological conditions amenable to treatment by this single measure. That method of presentation is apt to make a scientific physician skeptical that any single measure could be so widely indicated. When, however, it is recalled that all repair materials are conveyed to injured tissue by the active circulation, and that all defensive agents against bacterial invasion are also contained in the blood stream, it will at once be evident that any agent capable of markedly increasing the active circulation should have manifold indications.

History

The development of high frequency currents based on the original experiments of Faraday in the production of alternating, induced currents, took place mainly in the last decade of the previous century. d'Arsonval, Tesla, Nagelschmidt and others worked out the principles which are included in the modern diathermy apparatus. The first ten years of the present century witnessed the beginning of the applications of these currents to living tissue. Crude as was the apparatus then available, distinct heating effects were produced, with improvement noted in many conditions accompanied by impaired circulation. During the early part of the second decade we note especially, improvements in apparatus and engineering accomplishments which brought forth the multiple spark gap and relatively undamped oscillations.

Then came the vast clinical experience in the treatment of veterans of the World War which established many technics of proven clinical value. Since that time we have witnessed the extension of diathermy to the treatment of many diseases of the special

senses, of pneumonia and lastly the technic of general hyperpyrexia in the treatment of dementia paralytica.

The development of the cutting current as another addition to the surgical uses of high frequency current is also a very recent accomplishment.

That the value of diathermy as a therapeutic agent has been accepted somewhat slowly by the general profession, is due to several reasons. In the first place, far too many of the papers read in electrotherapy meetings were concerned with a few spectacular case reports, instead of large series with controls. The results obtained often seemed impossible to the physicians not thoroughly grounded in the physiological effects of these measures. Not knowing them, the profession has over emphasized what little psychological effect they may occasionally produce. Next we have the exaggerated claims for the use of individual instruments made by the "high pressure" salesman who, at the same time, is apt to minimize to the doctor the technical knowledge essential for good work. As we shall later see, the calculation of the proper diathermy dosage is based upon many factors of which the mechanical running of the machine is but a minor part. It is as poor a policy for the physician to attempt to use diathermy, with only such directions as the salesman has given him, as it would be for the surgeon to operate by a technique given him by the salesman of surgical instruments. Yet thousands of physicians have done just this, and it is no wonder that many disappointing results have been reported. Then we have the use of diathermy by men who may be renowned specialists in their own fields, but who attempt the use of these measures with no special knowledge as a background. When the almost inevitable failure ensues, the testimony of these men carries weight due to their general reputation, rather than that which should be accorded it, as a beginner in this special field. And fortunately we have, though rarely, the snap judgment condemnation of a measure unsupported by any knowledge or experience with it. In spite of

* Read before the New York Physical Therapy Society, April 8, 1931.

all these drawbacks the value of diathermy, when applied by those with adequate training, has been established as of value in the minds of an ever increasing portion of the medical profession.

Physics and Physiological Effects

There are but two fundamental electrical currents, direct and alternating. The various modifications of these two current types may produce chemical, mechanical and thermal effects in the tissues. The first effect, chemical, is produced only by the constant or galvanic current, because it is due to the concentration of one type of ion in the tissues under the negative or positive electrode. Mechanical effects may be produced by the modifications of either the direct or alternating currents. They are due: 1. To the irritation of the specialized motor nerve endings, or the muscle fibers themselves when deprived of their nerve supply. The interrupted, wave and sinusoidal galvanic, and the faradic current all act in the first instance while the faradic is incapable of producing response in the muscle fibers themselves. 2. By cellular and mass compression, indirectly due to the muscle contraction just mentioned, or directly as with static. Thermal effects are produced in any real amount only by the high frequency currents, and are due to tissue resistance to their rapid oscillations at high voltage. The d'Arsonval biterminal current, by means of which diathermy is obtained, alternates about a million times a second at a voltage of ten to thirty thousand. Being alternating, no chemical effects can be produced, and all mechanical stimulation producing muscle contraction ceases, when the frequency reaches above ten thousand per second. The only effect, therefore, is the production of heat and the tissue changes incident thereto. The apparatus is supplied by 110 volts, 60 cycle alternating current. If direct current only, is available, a motor generator to produce an alternating current is necessary. As the a.c. current is led into the machine it is first passed through a series of choke or resistance coils at the rheostat. This may roughly be considered to govern amperage of the current led into the primary coil. Here the voltage is raised in the primary circuit but the frequency is not affected. In the high frequency circuit are placed condensers and the spark gap, the latter acts as a variable air

resistance in the circuit, when opened it compels the current to pile up in the condensers until it has sufficient voltage to jump the gap. In the modern types of multiple gap, the spark is finely divided and almost continuously sets up a tremendous number of oscillations which increase the frequency to the desired amount, and again raise the voltage. Another device the milliammeter, records the number of milliamperes passing through the circuit in which the patient is included. It does not tell us the amount of internal heat produced. As the heat gradually increases in the pathway of the tissues between the electrodes, there follows a dilatation of capillaries and of the smaller arterioles. This represents nature's efforts to dissipate heat and prevent tissue damage, and is in itself usually the object of the treatment. Through the thinned walls and increased intracellular spaces of the dilated capillary, a greatly increased amount of nutrient serum escapes to bathe the surrounding tissue cells. The process of osmosis is made more easy, as is also the migration of phagocytes into the tissues, where infection is present. By this means as stated in the beginning of the paper, tissue repair, glandular activity and defense against local infection are all greatly eliminated.

Technic

There is a wide variety of acceptable methods for localizing heat within the tissues, which in itself adds no little interest to work with this current. The principles, however, that must be followed are quite rigid, and the proper calculation of both technic and dosage is often no easy matter.

Electrodes of many types are used. For the majority of our work we employ flexible composition metal, cut in suitable sizes and shapes. This metal is obtained in various thicknesses, such as 16, 18, 20, and 22 gauge. The medium thickness is usually to be preferred. Quite recently a new and very thin sheet of aluminum, the so-called Dr. Huth's Diathermy Metal, has been placed on the market, with certain advantages in the treatment of small joints. Some workers interpose saline soaked cellulose, gauge or absorbent cotton, and occasionally moistened chamois between the electrodes and the skin. We do not use any such material except in the intensive treatments to produce general hyperpyrexia. It is still felt that a heavy shaving soap lather, applied to the surface of the electrode is the best contact

medium. Others use gelatinous substances, plain water or dry electrodes. The latter will be found sufficient to maintain contact in most uneven surfaces and permits of a more rapid increase in the current than any other method. Opposed plates are always to be preferred for through and through heating effects. Where it is desired to localize the heat in one area close to the surface, a smaller electrode may be placed over it, plates or cuffs used on either side or a movable glass condenser may be used as the active electrode.

It should be here noted that the flat fiber pads supplied by most manufacturers make ideal dispersive electrodes, but should never be employed for autocondensation, where the dielectric space, provided by the autocondensation mattress, is essential. Both condenser and solid electrodes are employed in cavity work. When increasing the current the spark gap alone is usually regulated, the rheostat having been previously set to the point which will provide a smooth running gap at the desired milliamperage.

Dosage

The most important factor in dosage is the density of the current. This is calculated by the number of milliamperes divided by the square inch area of either electrode. It is calculated on the smaller if they differ in size. The maximum safe current density when everything is favorable is 100 per square inch. Usually, however, the patient will tolerate 60 to 75 rather better.

There are several conditions in which it is advisable to reduce this current density to nearly one-half that mentioned: 1. Where the circulation is impaired, as in arterio-

sclerosis, endarteritis, or masses of scar tissue. 2. Where the tissue pathway consists of a large proportion of bony tissue, as in passing the current bilaterally through ankle or knee. 3. Where the distance between electrodes is short as in an antero-posterior application to the wrist. 4. When for any reason whatever, local or general, the patient is unable to inform the operator of undue accumulation of heat. It should be kept in mind that two or three of these reasons for reducing current density may occur together.

Having mentioned the cautions which require reduction of dosage, in this connection two other situations come to mind for anatomical reasons, namely, diathermy of kidney and brain, in which very low dosage if any, is indicated. The real contraindications for the use of diathermy are only two. First, the liability of producing hemorrhage when vasodilatation occurs and, second, free pus without drainage. In addition it should be stated that the growth of a malignancy would probably be stimulated by diathermy, although its analgesic effects might be needed in spite of this possibility. The average treatment is twenty to thirty minutes, taking two or three minutes to slowly increase the current to maximum, and one or two minutes in its reduction.

In conclusion it should be kept in mind that diathermy other than in pneumonia, seldom constitutes a complete physiotherapy treatment. In most cases, some type of surface heat is first applied, and then some form of decongestion used following diathermy. It is already certain that this therapeutic measure will be found to be of increasing value as it is more and more widely employed.

RFN

ULTRAVIOLET IN THE PRACTICE OF STOMATOLOGY*

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The intelligent use of ultraviolet rays in the treatment or prevention of disease calls for certain qualifications on the part of those administering this form of treatment, just as other forms of treatment require special knowledge. This applies with equal force whether the disease under consideration manifests itself in one part of the body or another.

In order to treat a sick individual intelligently and successfully the physician (the term physician is used to mean anyone who treats disease of any kind) must have a clear mental picture of that patient in health and disease, and a very definite understanding of the particular disease for which relief is sought. Again this applies equally to Stomatology and other branches of the healing art.

A definite realization that oral diseases, whatever their nature, are not strictly local diseases, is paramount to success. In the very nature of things there can be no such thing as a strictly local disease, nor are the effects of any disease or lesion altogether local. Therefore when the stomatologist, or dentist, if you please, or anyone else, attempts to diagnose or treat any oral lesion, he is dealing with a sick individual and not just a certain portion of him, something apart from the rest of the body.

A patient suffering from typhoid fever, or other febrile disease, may lose his hair. How perfectly foolish it would be to treat that patient for alopecia and neglect the general systemic condition. No more illogical, this, than some things we see done, where the principle manifestation may be in the mouth.

Yet another pre-requisite to intelligent treatment is a knowledge of physiology and general pathology, and the other allied sciences, in order to distinguish clearly between health and disease, and recognize the symptoms of disease, and make proper evaluation thereof.

In addition to a knowledge of general pathology, a thorough understanding of the special pathology of the mouth and all of its associated parts is of the utmost importance.

It is not enough to recognize that structures are not in a state of health, but it is important to understand what is going on, and why. A good understanding of the pathopoiesis in any given case is necessary to intelligent diagnosis and treatment, whether ultraviolet rays or other methods be used.

Examination and Diagnosis

Careful examination and a diagnosis made in the light of present day knowledge, is the first step in determining what method of treatment is best suited in any given case. It is significant that exactly the same biologic principles and laws govern in the mouth as in every other part of the body and yet this fact is apparently overlooked by so many.

Unfortunately, examinations, too often, are rather perfunctory, and the diagnosis amounts to little more than "snap judgment." By way of illustration attention might be called to that overworked misnomer "pyorrhea," a term erroneously used to cover such a multitude of lesions, diagnosis of which is made so often by merely glancing into the mouth, and which certain manufacturers can diagnose in "four out of five" without even seeing the patient.

I am calling attention to these things because I believe they should be spoken of. It is very plain to anyone giving the subject careful thought that the dentist must have the same fundamental training as other branches of medicine in order to intelligently treat diseases of the oral cavity. It is equally apparent that the physician whether in general practice or any of the other specialties, needs some training in stomatology.

Speed the day when the two professions will be re-united so that all who treat diseases of any kind, or part, shall have the same basic training before going into the

* Read at the Tenth Annual Meeting of the American Congress of Physical Therapy, Omaha, Nebraska, Oct. 7th, 1931.

specialties. When the medical and dental professions become sufficiently awakened to the importance of this, our medical and dental schools will be obliged to meet the situation, which by the way is not an insurmountable one.

The use of any therapeutic agent by rule of thumb too often results in failure, not because of the agent used, but due to a lack of an intimate knowledge of the means employed, its possibilities and limitations.

Ultraviolet rays have certain definite bio-physical or biochemical effects when the animal organism, or living tissues, are exposed to them. Medical and dental literature is replete with reports of the findings of research workers in this and other countries.

Bio-Physical Effects

Certain properties of these rays have been well established and will be merely mentioned here. Their calcium and phosphorus fixing powers and vitamin D activation have been well established. In other words they are anti-rachitic in effect. Phagocytosis is increased as shown by many observers.^{(1), (2), (3), (4), (5), (6)} Stimulation with resultant increase of capillary circulation follows irradiation.^{(1), (7), (8)} The rays are highly bactericidal to micro-organisms coming into optical contact.⁽⁹⁾ Ultraviolet rays have analgesic properties. The shorter wave-lengths are highly cytotoxic.

Many claims for the curative powers of these rays, some of them bordering on the ridiculous, have appeared in the literature. However, the well established properties and effects mentioned above will suffice for our consideration.

With a knowledge of such effects and a diagnosis carefully made, the stomatologist should be able to determine whether or not ultraviolet ray therapy is indicated.

The fact that the mineral metabolism is disturbed in so many diseases of a deficiency nature makes this form of therapy of value in caring for such patients.

Types of Oral Diseases

Periodontal diseases in which there is a destruction of the alveolar process of the maxillary bones, or mandible, may be suppurative or non-suppurative, depending upon whether or not the lesions have be-

come infected with pyogenic micro-organisms.

We may divide periodontal diseases for the purpose of this study into two classes. First, those in which osteitis develops as a result of local irritation. Secondly, those in which no such local irritants are present but where there is a persistent, progressive absorption of the alveolar processes; namely, a true osteomalacia—a deficiency disease. In both types of cases, ultraviolet therapy is of benefit when given its proper place in the treatment.

Like elsewhere in the body, the bones of the alveolar process of the jaws are very susceptible to irritation. In other words Nature will absorb the bones in an effort to get away from an irritant. Therefore it is essential that all irritants be removed before we can hope to get results in treatment of periodontal disease.

All overhanging or poorly contoured fillings of teeth must be replaced by properly contoured and finished restorations. When I speak of the contour of artificial restorations, I mean to convey this thought. In just so far as the artificial restoration fails to restore to the minutest detail the contour and anatomical detail of the natural tooth, the whole operation is a failure.

The same is true of artificial crowns whether of gold or any other material. A poorly fitted, or contoured crown is a menace while a properly fitted and contoured crown is an exceedingly valuable substitute for the natural tooth and one that harbors no danger to the patient.

Unfortunately there are many artificial crowns that are a menace. This does not mean that every gold crown is of that type. It is a tragic fact, however, that some physicians are unable to distinguish between artificial crowns, bridges or tooth restorations that are of the highest type, rendering a valuable service, and those that are the worst possible menace to health: veritable cesspools which insidiously kill the patient by inches.

What is still more tragic is the fact that so many dentists are apparently unable to distinguish between a high type of artificial restoration and those of a lower type, and are advocating the wholesale loss of teeth just because they can see gold in the mouth.

Calculus a Factor

Deposits of calculus, either salivary or serumnal, upon the roots of the teeth, are a frequent cause of periodontal disease. Very often this is not visible but lies under the free margin of the gum. No such case will get well until a thorough curettment of all exposed root surfaces is accomplished.

Irritants having been removed so that the traumatized tissues can heal, the proper use of ultraviolet rays will hasten the regeneration of the bones and the return to normal of the overlying gum and muco-periosteum.

Local and Systemic Treatment

Local irradiation, by means of suitable speculae and applicators, is indicated for its stimulating effect and the greater flow of blood to the parts which follows, thereby overcoming congestion and the train of consequences which result from sluggish circulation.

Body irradiations are of benefit for raising the general resistance and calcium fixation in the rarified bones.

In cases such as we have been discussing, pyogenic infection is frequently a complication. The shorter rays, especially (rays of short wave length), are bactericidal to a marked degree. Consequently irradiation of the infected areas will reduce the number of infecting organisms by destroying those bacteria coming into optical contact with the rays. However, this effect is limited by the very slight powers of penetration of the rays so that no great reliance can be placed on destroying any but surface bacteria by local irradiations. The increase in the number of phagocytes in the field, I believe to be of far greater importance. Bone that is completely destroyed will not be rebuilt.

It should be said, however, that when the organic matrix of the bone has not been completely lost, the use of ultraviolet rays, both locally and general body treatments will promote recalcification.

Osteomalacia

A far more serious and complicated disease of the periodontal structures is osteomalacia, technically spoken of as periodontoclasia. Here we may find no signs of infection; no pockets around the teeth; no apparent irritations. Frequently the condition is seen in mouths that hygienically are

all that could be desired. This is truly a deficiency disease and no amount of local treatment will stop its steady progress. The teeth may loosen and be lost, and the absorption goes on until the alveolar ridges of the jaws are more or less completely destroyed.

Artificial dentures placed in the mouth of such patients become loose due to further absorption of the bones. Abrasions of the muco-periosteum occur under artificial dentures due to uneven absorption. The whole picture is a rather discouraging one to the patient as well as to the stomatologist, for all of this may take place while the patient is apparently in good health.

Such individuals are really suffering from a calcium and phosphorous deficiency and Nature is drawing upon the most available source of supply, viz., the bones. In earlier writing I have called attention to the high vascularity of these bones as the reason for their mineral contents being more readily absorbed than those of the denser bones.⁽⁸⁾

Whether this disturbance of the mineral metabolism is caused or aggravated by a deficient diet, a lack of the vitamins or sunshine, pregnancy or lactation, the effect upon the bones of the jaws are the same, and if the disturbance is severe enough all of the bones will be affected.

Ultraviolet radiation is used in such cases for their antirachitic powers, primarily. Irradiating the skin, that is, general body irradiation, will restore a lowered mineral metabolism to normal, provided of course, there is not some other underlying cause for the disturbance.

A diet sufficient in the mineral elements and vitamins must be provided if results are to be permanent. It is significant, however, that in most cases, it is the patient's inability to assimilate the mineral elements, rather than a lack of them in the diet which needs to be remedied.

Local irradiation of the mucous surfaces over the alveolar processes is of benefit in stimulating the bone cells to greater activity in depositing new bone material in the rarefied areas. Beyond their stimulating effect I do not believe that local irradiation is of value in this type of case, but clinical experience has shown that proper irradiation of the body surfaces does have a marked effect, so that rarefied and weakened bones

regain their normal density and ability to support the teeth.

It is only reasonable that unless the patient's mode of living can be so changed as to effect favorably the metabolic processes the treatments must be continued regularly and indefinitely.

Vincent's Disease

Both local and general irradiation is advantageously used in the treatment of Vincent's stomatitis and angina. Here again the increased phagocytosis is an important factor in overcoming the infecting organisms. Vincent's spirochete and the fusiform bacillus, being anaerobic organisms, are adversely affected as a result of the increased oxygen carrying capacity of the blood following irradiation of the skin.⁽¹⁰⁾ The coagulation time of the blood is lengthened in this disease. Ultraviolet irradiation of the body surfaces decreases the clotting time.⁽¹¹⁾ This is very valuable in acute cases, in some of which the danger from hemorrhage is a serious one. This result is probably due to lowered calcium balance.

The application of the rays directly to the lesions in the mouth is highly beneficial. The direct bactericidal effect is undoubtedly of some importance, but I believe the oxidizing reaction as described by Eidinow⁽¹⁾ to be the principal factor in the destruction of the infecting organisms.

The stimulating effect, when applied locally, upon tissues in a state of lowered vitality is beneficial in raising the resistance and recuperative powers of the structures directly involved.

In this disease we have one in which all four methods of treatment is called for, viz., medicinal, dietetic, surgical and physical, no one of which will take the place of the others.

Surgery and Ultraviolet

In conjunction with surgery there is a place for ultraviolet ray therapy, both pre-operative and post-operative. The danger of post-operative hemorrhage is greatly reduced in patients showing an increased coagulation time by giving a few body irradiations before operating. Secondary post-operative hemorrhages are controlled by general irradiation very successfully in some cases. I do not believe that local irradiation of the bleeding wound is of any value, al-

though there are many physicians who advocate this procedure.

In spite of the power of the rays to increase the calcium content of the blood, thereby shortening the coagulation time, other well established methods of accomplishing the same end should not be overlooked.

Dental Caries

While there is much about the etiology and pathogenesis of dental caries that is as yet not understood, we do know that this disease is subject to the principles of susceptibility and immunity, just as other and better understood diseases. Just what influence calcium, phosphorus and other mineral concentrations of body fluids has on susceptibility and immunity to caries has not been determined. That it has an important bearing, I believe. Clinical evidence seems to point that way.

At least I have been able to change extreme susceptibility to a much lesser susceptibility by systematic exposure of the body to ultraviolet rays within a period of weeks or months. What the future holds in this direction only time and further studies will tell.

There are many mouth lesions that might be mentioned specifically in which this form of treatment is indicated. I shall not do so. I have tried to show the type of diseases where it is of benefit, rather than minutely differentiated variety. After all one's ability to use this or any other remedy successfully depends upon his having a knowledge of the basic principles and a faculty for reasoning things out for himself.

Application and Dosage

The fractional irradiation method seems to be preferable to exposing the entire body at each treatment. The exposure should be such as to stay below the tanning dose.

If there is evidence of tanning of the skin it is better to change to some other part of the body in order to have the skin remain light sensitive. Then in a few days the same area can be exposed again. If a larger area, say, the chest and back are exposed each time, giving a correspondingly smaller dose on each surface, light sensitivity is not nearly so apt to be lost as when a smaller area is given a heavier dose. A first degree erythema dose should not be ex-

ceeded when used for the purpose here considered. Intensity of the rays and distance from source of the rays will determine the length of exposure.

Either the air-cooled quartz-mercury arc, or the carbon arc, are the most convenient source of the rays for general body treatment.

The local application of the rays, within the mouth, is technically much more difficult. The rays should be directed as nearly as possible at right angles to the surface under treatment. Dehematization of the area is advisable in many cases and should be accomplished by pressure rather than the use of drugs.

Speculae of various shapes and sizes, and quartz applicators of special design are necessary to reach the parts desired. The use of photo-sensitive dyes in very dilute solutions is probably of benefit. However, Eidinow,⁽¹⁾ has shown that these agents lose their ability to unite with the bacteria in the presence of serum due to their greater affinity for the proteins and colloids of the serum than for the bacteria. Hence the value of photo-sensitive dyes for enhancing the bactericidal effect of the rays within the mouth is somewhat questionable. Stimulation is readily accomplished when the structures are kept relatively free from mucous and saliva.

The dose depends upon the reaction desired. Sometimes a mild and at other times a severe reaction is desirable. I frequently give a third or fourth degree erythema dose to advantage.

It is impossible to give definite rules for length of exposure inasmuch as generators and applicators vary so much in efficiency. In a former paper on the subject I have described in detail how to measure the dose of the water-cooled generator in volt-seconds.⁽¹²⁾ I believe I am the first to have described any method of measuring or duplicating dosage.

The water-cooled generator is the most practical for irradiating structures within the mouth, as it is for treatment of any of the body cavities. Another advantage of this type of generator for local treatment, over the air-cooled or carbon arc, is that by operating the generator at a lower temperature the rays of shorter wave lengths are

emitted. These rays are highly stimulating and are advantageously used in many cases.

Summary

Ultraviolet ray therapy is one of several valuable means of treating diseases of the oral cavity.

A thorough knowledge of their biologic effects and a keen perception of the pathology involved is necessary for intelligent and successful use of this or any potent remedy.

Some periodontal diseases are primarily deficiency diseases, while others are complicated by a disturbed mineral metabolism.

Benefits from ultraviolet treatment are both direct and indirect.

Not all oral lesions call for ultraviolet ray treatment; in many instances treatment calls for a combination of dental prophylactic preparation prior to irradiation, or the association of medical aid in the management of stomatologic pathology.

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E D I T O R I A L S

CANCER AND MODERN METHODS OF CONTROL

Our helplessness when confronted with a full-blown cancer situation has so indelibly impressed itself upon the collective minds of the medical profession that its eradication has become the outstanding purpose of modern medicine. Its insidious onset, its progress against all opposing medicaments, the inevitable invalidism and suffering of its victims—the living martyrdom—has surrounded the cancer patient with an aura of tragedy, the pathos of which has challenged the unified efforts of modern science to increased action. Compared to many of the unconquered maladies with which the profession has actively concerned itself, nothing so depressing—nothing so unspeakably agonizing and intolerable to patient, family or physician—has ever confronted the healing art. To conquer this protean malady, researches vast in character and detail have been instituted. Much has been accom-

plished toward a better understanding and control of this malady.

It is today conceded that malignancy is an abnormal process the virility of which depends on the disobedience of recognized biologic laws. Cytologic studies have confirmed the amicrobic nature of this disease, its anarchistic tendencies. From the very onset of organized research, opinions have gradually converged to two phases of the problem: the discovery of its cause and the eradication of the neoplasm. With the realization of the Gargantuan task before them, a natural and perhaps a protective corollary has grown out of this endeavor, namely, that prevention by early recognition is of paramount importance. This, the statistical phase, has developed today into one of the most important defenses against the spread of cancer.

In spite of the tremendous offensive directed against the nature of this malady, an offensive which involved the unified forces of the chemist and biochemist, biologist,

physicist and biophysicist, and perhaps many other intricate branches of science, nothing has been specifically isolated from the terrain of this disease. The cause of cancer is still unknown. Theories and counter theories have momentarily held our attention, only to have sunk back into desuetude and rejection. Ever so often therapeutic suggestions have flashed before the profession only to fall back into the limbo of false hope. Science has experienced setbacks, but its morale has been strengthened by many minor victories, sharp skirmishes, and several victories of a major nature. In the field of serology at least 26 cancer reaction tests are now recognized, the majority of them having been either discredited or not fully confirmed.

The vaunted Abderhalden test which based its action on the assumption of the presence of specific ferments, has been so thoroughly discredited that it is only mentioned because of the high hopes that it created for a period of time. Unconfirmed also is the test of Pfeiffer⁽¹⁾ who claimed to have demonstrated specific anaphylatic bodies in the serum of cancerous individuals.

There are grounds to support the probability of changes in the colloidal composition or characteristics of the blood serum in the presence of malignancy. McDonagh in his volumes, *The Nature of Disease*, has devoted at least four chapters to the exposition of the changes in which the static and dynamic structures of the body undergo in the presence of chronic irritation. He points out that the defensive mechanism of the cell undergoes certain changes, "brought about by an excitor taxing the defense resources of the cells affected or by the local production of anaerobic conditions, which later can conceivably occur in the absence of an irritant or excitor." This theory is in accord with Warburg's work, which showed that cancer cells have a manifold capacity over normal cells, even when the latter are at work, to form lactic acid from glucose.

Several reactions based upon colloid phenomena have been contributed to the cancer problem, but their authenticity is still doubtful. The Ascoli-Izar⁽²⁾ "Meistagmin Reaction" bases its value upon its ability to demonstrate a reduction of surface tension when malignant antigen is mixed with an equal amount of the patient's serum. Many

have claimed fairly reliable results but its disadvantage is perhaps in the meticulous technic that must be observed to overcome the possibility of error.

The flocculation tests of several investigators have shown great promise. Fry's⁽³⁾ saline emulsion of the acetone-insoluble and alcohol-insoluble substances of tumor tissues in the presence of tested sera's has shown in 494 cases of malignant disease a positive reaction in 72.3 per cent, while 77.3 per cent, of negative reactions were encountered in 506 control patients. The Gruskin⁽⁴⁾ test appears to possess the greatest possibilities. Basing his conception upon the assumption that each cell in the ordinary course of normal cell growth produces a lysis for another type of cell, Gruskin attempted to produce lytic agents by inoculating animals with purely embryonic cells, epithelial cells in the case of carcinoma and connective-tissue cells in the case of sarcoma. The amboceptors thus produced are utilized for the production of specific flocculation with serum from cases of malignant tumors. The results have shown a high degree of specificity for this flocculation test.

No less than the serologist and cytologist, the clinician has concerned himself with the problem with equal intensity. By his greater orientation with the problem, his defenses have been markedly increased. For the insidious nature of its onset the clinician has at his disposal a potent ally in the x-ray. The fluoroscope and the roentgenogram are today recognized for their supreme visualization possibilities in regions where the eye is not able to penetrate. The pathologist with the aid of the microscope is able to detect the aberrations of the micronic cell and and to thus differentiate the normal from the pathological structure. The importance of the biopsy test and the x-ray is today universally recognized and has the same relation to our problems as the advance guards of an army or perhaps the mobile units of the air force to the main body toward its rear.

The greatest advances, undoubtedly, have here been achieved by means of radiation and surgery. Although no decisive victories have been obtained, the high orientation of present-day technic in the fields of x-ray, radium and surgery bespeaks for a more

optimistic outlook for future sufferers. Moreover, the additional feature of intensive educational propaganda recently initiated by cancer control organizations has been a vital factor in the reduction of the morbidity and mortality of many an active cancer situation. The lay world has become more cancer-minded and the profession more cancer oriented. Constant warnings of the fatal consequences of procrastination have resulted in the saving of many lives and economic distress.

The dual possibilities of x-ray — therapeutic and diagnostic — are today utilized on a larger and indeed a better controlled scale than ever in the history of its practice. It is an agent who's forces can be directed for great good and for irretrievable harm. In the hands of the ignorant it has provoked untoward effects; in the hands of experienced roentgenologists the results achieved have often been dramatic. Our control of the cancer situation has further been fortified by the recognition of the gradient resistances assumed by the neoplasm toward radium or x-ray. By means of biopsy studies a therapeutic classification has been recognized for the better control of the treatment.

That radiation therapy has certain advantages over scalpel surgery has long been recognized. Undoubtedly many in the profession have been influenced by the non-traumatic, non-scarification effects of the roentgen and gamma rays in favoring the latter method to the exclusion of the former. Many experienced surgeons have discovered vital objections to surgery on account of its high mortality. Findley⁽⁶⁾ elsewhere in this issue, places radiation above surgery on the basis of statistical results obtained by both methods. Unfortunately, the finality of his stand regarding surgery as a whole is due to an obvious error in his surgical orientation. Surgery is on the crest of a new adventure that promises most decisive results. We refer to the new surgery — electro-surgery — now exploited by Howard Kelly and Ward, Keysser, Doyen, and Clark. The decisive possibilities of electrosurgery have now reached a new note, a therapeutic crescendo, in the form of the sustained high frequency cutting current — electrotomy. Extirpation of deep seated neoplasms can now be obtained with as safe a facility as by

the orthodox scalpel, providing, of course, that the operation is performed by an experienced surgeon. It has advantages over the scalpel and electrocautery in that it produces a minimal of bleeding and scar tissue formation, healing by first intention, prevention of shock and the closure of the lymphatic circulation, thus insuring against metastatic dissemination.

The management of cancer requires today a high orientation in all branches of medicine. The problem is so inter-related that it has assumed a specialistic nature. Until the future points out a more specific route it will remain a problem best controlled by the highest co-operation of the internist, surgeon and radiologist.

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ADVANCES IN ULTRA-HIGH FREQUENCY RADIATION

Ever since medical high frequency currents demonstrated their deep heating properties continual investigations have been carried out to prove the reconstructive values of this type of treatment. Initiated by d'Arsonval,⁽¹⁾ it was discovered that currents reversible above 5000 cycles per second not only diminished the neuro-muscular contraction of tissues, but that in proportion as the frequency of the current was raised a strange sensation of heat was evoked. Since then a restless progress has been observed within the ranks of those interested in this particular field of study. Side-by-side with the increasing knowledge regarding its physiologic and lethal properties definite progress has been attained in relation to the physical nature of high frequency currents. It is now realized that its destructive action is based upon physical effects produced by currents related to the electromagnetic spectrum, designated as radio-frequency,

rather than to those allied with the so-called ordinary electrical currents.

Undoubtedly, the potentialities of this spectral region have in recent years demonstrated great possibilities for both economic or therapeutic use. In its medical application its usefulness became proportional not only with wider clinical experience, but, perhaps in a greater measure, with evolutionary innovations in the electrical circuits that entered into the construction of the new apparatus. Several distinctive modifications have taken place in high frequency instruments. The condenser field as produced by the early d'Arsonval solinoid type, soon was replaced by the higher frequency and lower potential currents of the Nagelschmidt variety, and this in turn by the more recent variations which have emphasized modifications in spark-gap, amperage and frequency.

Within the past few years additional modification in circuits, those designated medically as ultra-high frequency currents, have provoked considerable comment, because of the striking and unexpected physiological and biological effects produced by electromagnetic waves of the frequency of 50 metres and under. In physical make-up, the nature of this circuit is a radical departure from the one utilized in average so-called diathermy outfits. In order to provide a readily controlled high range of frequency, it has been found desirable to incorporate vacuum tube oscillations, so modified by the interposition of a control element or grid as to permit an increased sensitivity of the field. This regulates continually and uniformly the power of a direct current supply in accordance with the need of the oscillatory circuit, and has given us a method of generating a continuous train of ultra-high undamped oscillations the energy of which is only dependent upon the amount of power given to the circuit by the tubes.

Different devices are in the market today which in outward appearance suggest the farthest removal of mechanical relationship. All are however basically related by the similarity of the oscillating circuit, the deep heating effects of which must be explained on a similarity of mechanical construction. According to De Walt,⁽²⁾ "The mechanism of the actual heating is not entirely known, but it is fairly definite that the heating is due to two causes: power loss in the body due to its resistance to the current passing through it,

and the power loss due to what may be termed dielectric hysteresis." Translating the condenser field action on speculative material, De Walt offers as an illustration the heat producing effect of external and internal friction on elastic rubber by the explanation that, "This heating is a function of the frequency, or rate of stretching, and is analogous to the loss caused by a current flowing through a resistance and to dielectric loss."

Progress in this discipline has now reached a stage of perfection wherein speculation has given way to actual knowledge. Gossett, Gutmann, Lakhowsky and Magron,⁽³⁾ in 1914, pointed out the effects of 2 metre condenser fields on plant tumors. Schereschewsky⁽⁴⁾ noted their lethal effects on mouse tumors. Bierman,⁽⁵⁾ called attention to the coagulating phenomena in mice and made the following observation: "We were able to raise the temperature 8° C. within a period of ten minutes (to 43.3° C.) before killing. We picked the animal up by the tail and the tail came off! The tail had coagulated and separated with the same ease as though it was amputated." Carpenter⁽⁶⁾ studying the effects of syphilis on rabbits in an environment of ultra-high frequency current noted the favorable effects produced. This was exemplified by the reduction of the scrotal chancre and the controlling of the Wassermann and Kahn tests. He states: "We can conclude that the heat produces in the body an unfavorable environment for the spirochete. Secondly, we think that there is thus produced an augmentation of all the chemical processes, especially those which are concerned with the defense of the body." That conductivity is directly proportional to frequency and follows Ohm's law of resistance has been demonstrated by McLennan,⁽⁷⁾ on various electrolytic solutions, as well as by Pflomm,⁽⁸⁾ and Pätzold.⁽⁹⁾

Schliephake's⁽¹⁰⁾ notable contributions to this study are unquestionably the outstanding work of German origin. His pioneer work in this field not only confirmed the earlier reports of other investigators, but in addition to this he has anticipated the researches of future workers by paving their way by comprehensive studies in the related fields of biophysics and clinical medicine. He has shown that short wave therapy influences the various tissues of the body differently than that of diathermy. In regard to the fluid constituents, in relation to heat concentration, wave-

lengths of 3-3.70 m. were shown to be the heating optimal for total blood, whereas wavelengths of 2.50-2.80 m. were proven maximum for serum. In 4 m. wavelength fields, the viscosity of human serum was definitely reduced. The antitoxin effects of diphtheritic sera was maximally influenced with 3 m. wavelength condensor fields. Four metre wavelengths apparently showed the greatest heat specificity influencing phagocytosis.

That wavelength has a definite influence on heat concentration within the fluids outside of the body was demonstrated by the simple experiment of placing two equal sized test tubes, one partly filled with 0.41 per cent sodium chloride solution and one with 0.1 per cent silver solution, respectively, in each of three glass beakers, containing distilled water. Similar thermometers, registering centigrade fractions were placed in each test tube and beaker. The passage for 5 minutes of a 15 m. wavelength showed an increased temperature in the collargol solution over that of the salt solution, in contrast to the increased temperature in the salt solution over the collargol when a 3 m. wavelength was passed through for the same period of time. In either experiment the water temperature remained the same. The third experiment dealt with the comparative influence of a diathermic current passed through a similar environment as above. The temperature here showed the highest rise in the distilled water, then in the sodium chloride solution and lowest in the collargol. This reaction is in accordance with the ohmic resistances encountered: the temperature rose proportionately to resistance.

Translating the foregoing experiences into the realm of clinician, it now becomes possible to utilize ultra-short wave radiation in a variety of clinical conditions in which lower high frequency current have been found impractical. The fact that shorter wave therapy is able to pass with greater ease through dielectric fields such as fats, bone and brain substances, and raise the temperature of deeper structures in a manner more uniform than by diathermy, opens up an avenue of new therapeutic possibilities, the wider exploration of it being only a matter of time. Indeed, a great deal of impetus has already been developed as regard its clinical utility by Schliephake in Germany, and Bierman in New

York. A survey of Bierman's⁽¹¹⁾ complete report published elsewhere in this issue confirms the growing conviction that a new approach is being established, which promises greater therapeutic possibilities, the limitation of which remains a problem for future research to determine.

It is gratifying to realize that seldom has more complete team work been displayed by the physicist and the medical profession in its investigation of the physical nature and therapeutic possibilities of ultra-high frequency radiation. There has here been no fan-fare of publicity to disturb the even tenor of its progress. Practically every phase of the problem has been studied, to the point that this agency now enters the clinical field with a background satisfactorily rounded out by meticulous and conservative research in the orthodox branches of the biological sciences. The circle of investigation now apparently comes back where d'Arsonval first initiated it, in that therapy by condensor field methods now promises an additional increase in our therapeutic facilities, even beyond that anticipated for it by the early pioneers.

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POST-GRADUATE SEMINAR OF PACIFIC PHYSICAL THERAPY ASSOCIATION

In the past several years the Pacific Physical Therapy Association has demonstrated its progressiveness by inviting recognized authorities to discuss the latest contributions in Physical Therapy. Many of these programs were sufficiently extensive to be designated as post-graduate courses. Initiated first by the late Granger, these lectures have annually been supplemented by the addresses of such representative men as Coulter, Grover, Mayer, and others. Attendance and appreciation has grown apace with the increasing interest in physical therapy procedure. It has been the means of not only offering our Pacific Coast colleagues an impressionistic picture of the cosmopolitan viewpoint of their invited guests towards the whole discipline, but it has, moreover, given them the unusual opportunity of closer contact with the newer advances in the subject.

The response to these programs has been so gratifying that, this year, in spite of unfavorable economic conditions, the foregoing Association in connection with the endorsement of the Los Angeles County Medical Association, has obtained as its invited guest Richard Kovács, of New York, who will conduct a seminar in Physical Medicine, the week of July 18 to 23, in Los Angeles. The wide experience of Kovács on the lecture platform promises to make the Seminar an assured success. The program calls attention to the wide range of subjects that will be adhered to by the speaker. An outline of the course includes both didactic expositions and clinical demonstration encompassing the fields of electro-physics, physiology and electropathology; also low and high frequency therapy, (medical and surgical), infrared and ultraviolet therapy; massage and therapeutic exercise.

The purpose of this seminar is apparently broader than the mere recitation or demonstration of the indications and counter-indications of physical therapy procedure. It is intended to also stress the practical utility of physical measures in relation to the general practitioner, and the physical therapy department in relation to hospital practice.

It is our conviction that such programs have a decided utilitarian purpose. Their popularity has been indicated by the large attendance they have evoked in other parts of the country. Organized medicine in America, through the well directed and conservative efforts of the Council on Physical Therapy is today regarding Physical Medicine as a benevolent adjuvant in medical practice. Seminars of a like nature should be encouraged in other sections until such a time when the need for it will be replaced by recognized teaching institutions all over our land.

PENNSYLVANIA SEMINAR ON PHYSICAL MEDICINE A GREAT SUCCESS

During the week of April 18, 1932, the Committee on Education of the Philadelphia County Medical Society, in collaboration with the Pennsylvania Physical Therapy Association, presented at the Philadelphia County Medical Society Auditorium a free Seminar on Physical Medicine.

This seminar included symposia on the following subjects:

- (1) Light Therapy.
- (2) Electrotherapy.
- (3) Hydrotherapy.
- (4) Mechanotherapy.
- (5) Physical Therapy in Bone and Joint Diseases.

Outstanding authorities from all parts of the United States cooperated by coming to Philadelphia to deliver addresses in the various symposia. They included W. W. Coblentz, Willis S. Peck, Edgar Mayer, H. J. Holmquest, Richard Kovács, Norman E. Titus, William Bierman, Harry E. Stewart, Grant E. Ward, Henry C. Bazett, Heinrich Wolf, LeRoy W. Hubbard, K. G. Hansson, Harold D. Corbusier, and Clay Ray Murray.

In addition, clinical demonstrations, correlated with the didactic lectures of the seminar, were given at the Graduate Hospital by Drs. W. T. Johnson and F. A. Cochran and Staff; at the Jefferson Hospital by Dr. W. H. Schmidt and Staff; at the Temple University Hospital by Dr. F. H. Krusen and Staff; and at the University of Pennsylvania Hospital by Dr. J. B. Nylin and Staff.

This seminar was, we believe, the most suc-

cessful of its kind ever attempted, there being, to the surprise of the Committee, over 400 physicians registered for the course. Over 60 physicians attended the course from parts of Pennsylvania outside of Philadelphia. In addition, there were 2 registrants from California; 2 from Delaware; 1 each from Florida, Illinois, Kentucky and Missouri; 8 from New Jersey; and 1 from Wisconsin.

This attendance, plus the wide geographic distribution of the speakers (who came from Connecticut, District of Columbia, Georgia, Illinois, Maryland, Michigan, New Jersey and New York), gave the seminar a far more national scope than was expected.

It also fully demonstrated the widespread interest of the practicing physician in physical therapy.

The Chairman of the Committee on Physical Therapy of the New York State Medical Society wrote, "May I express my most sincere congratulations on the program of your Postgraduate Seminar in Physical Medicine. It is the most thorough and most impressive piece of work of this sort as yet undertaken." One of the registrants wrote, "I attended all the didactic lectures with profit to myself, and in addition I feel that the Committee performed a most useful and praiseworthy service." Another registrant wrote, "I spent a profitable and enjoyable week, missing but one lecture and have now some clear ideas about physical medicine, where before I was hopelessly confused. If the various papers are to be published, I should greatly appreciate an opportunity to get copies of every one of them."

All physicians interested will be glad to know that papers presented before this seminar are to be published in the next two volumes of *The International Clinics*; and that in September, 1932, the entire group of lectures will be available in a single separate volume.

Since there were fifteen different lectures, covering all important phases of Physical Therapy, the published proceedings of this Seminar should be almost a text book in itself.

It is sincerely hoped that other County Medical Societies throughout the country will establish such courses in Physical Therapy. The Committee which organized this course has expressed its willingness to cooperate with any other County Medical Society or organized medical group in establishing similar

courses. It will be glad to lend the benefit of its experiences to any such group.

There are no doubt many physicians who, like the registrant quoted, are "hopelessly confused" concerning physical therapy, but, unlike him, have not had the opportunity to gain "some clear ideas" concerning it. The medical organizations are, therefore, urged to establish such seminars elsewhere, in order that practitioners may be properly acquainted with the recent developments in Physical Therapy.

FRANK H. KRUSEN,

Chairman, Committee on Arrangements.

ARCHIVES BECOME OFFICIAL JOURNAL OF PACIFIC PHYSICAL THERAPY ASSOCIATION

An official communication from our indefatigable Californian, Hibben, Secretary and Treasurer of the Pacific Physical Therapy Association, and Vice-President of the American Congress of Physical Therapy, brings tidings of mutual satisfaction; namely, that the foregoing leading organization of the Pacific coast has adopted the ARCHIVES OF PHYSICAL THERAPY, X-RAY, RADIUM as its official journal. The Editor is pleased to acknowledge through these columns his personal gratification and the satisfaction of the Congress in this affiliation.

Sentiments of mutual respect have gradually transcended the vast geographical distances that have separated both organizations. The tenuous linkage of mileage and the Rocky Mountains has gradually been strengthened by the attractive forces of similar aims and purposes, and the formulation of programs based upon scientific elucidation of Physical Therapy.

There is every practical reason for even a closer bond of both organizations. Their activities and ambitions run parallel, in that both are attempting to exploit the highest educational values from the same discipline. Members in both organizations are Fellows of the American Medical Association. In principle and practice there is need of an organ that attempts to disseminate information not only specialistic in nature, but such that has been critically and conservatively evaluated as sound, orthodox and scientific prior to its introduction for the consumption of the practitioner. The ARCHIVES invites the Pacific Physical Therapy Association to make use of

its columns and to report not only scientific transactions, but to elect an editorial representative from its group who will officially execute the literary responsibilities to their personal satisfaction.

The present trend of organized medicine in relation to Physical Therapy is less of hostility and more of open mindedness. There is need today for more organized and controlled observations—observations that detail the clinicians experiences in a vein similar to the dispassionate and unbiased reports emanating from recognized laboratories. Research in scientific Physical Therapy is not a closed corporation, limited to scholastic laboratories or to certain geographical centers. Indeed, the Pacific coast is especially endowed in both scholastic and technical institutions from which much may come of benefit to our specialty. It is highly desirable, therefore, that an oriented representative with editorial qualifications should be the *liaison* officer not only as a contact between both respective organizations, but one through whom should filter the advance news and contributions west of the Rocky Mountains. The ARCHIVES feels itself greatly strengthened in anticipation of this prospect, and welcomes the cooperation that it feels sure to obtain from the individual members and the Pacific organization as a whole.

NEW YORK INVITES YOU; COME TO NEW YORK FOR THE ELEVENTH ANNUAL SESSION!

The eleventh annual session which opens informally at the Hotel New Yorker, New York City, on September 5th, has already drawn more than the usual interest which medical gatherings nowadays attract. This is only natural when one appreciates the excellent program which has been arranged. The newer problems in physical therapy—therapeutic fever, electrosurgery of tonsils, colonic therapy, and the application of physical measures in stomatological practice,—all come in for detailed discussion. Prominent clinicians and teachers will present scientific papers and clinics representing the recent advances in the field.

With few exceptions, probably no subject in medicine has received the attention of research workers as has the production of artificial fever by diathermy. The perfection

of apparatus has made it possible to employ artificial fever as a therapeutic agent. The results attained with it in paresis, arthritis and other diseases has merited such consideration that organized and systematic investigations are now being conducted in many of the larger universities and medical centers. A symposium on fever therapy, in the section on medicine, will be presented by outstanding investigators, and aside from the clinical aspects of the subject, the physical and physiologic aspects will be dealt with adequately. Methods and apparatus likewise will be discussed in great detail. From this symposium and the discussions which will follow, should develop much that is of interest and value to the medical world.

Another important subject which is always of prominence is that of arthritis. Physical measures have contributed in no small way to the modern management of arthritis. Physicians now fully appreciate this fact and are always welcome recipients of new information which may throw some light on the treatment of this disease. The symposium on arthritis as it has been arranged should prove alluring to the internist, the general practitioner and the specialist, all of whom at some time or another come in contact with the arthritic patient in the course of routine examinations.

Other symposia on tuberculosis, cancer, electrocardiography, corrective exercise and urology are most ably represented by capable clinicians, the large majority of whom hold teaching positions in America's leading medical schools.

The section on eye, ear, nose and throat, as in previous years, should be well attended. Electrosurgery of tonsils holds the leading place as the subject to be presented in symposium. Not only the advantages of this method, but also its limitations will be thoroughly outlined by specialists who are qualified by extensive experience in the work.

The new sections on colon therapy and stomatology should prove of special interest to physicians and dental surgeons, respectively, who are concentrating in these branches of work. Ample opportunity will be afforded for an exchange of views and for reports of clinical experimentation. In the section on stomatology, as well as in all

the other sections of the Congress, licensed dental surgeons who are in good standing are eligible for admission and will be welcome guests of the organization.

Fellows and guests who plan on attending the eleventh annual session are urged to come to New York on Monday, September 5th, in order to be on time to attend the President's Dinner on the evening of that day. A very interesting but brief program has been arranged for the occasion and a pleasant evening is assured. The occasion has been planned so that those desiring to attend the theatre or other places of entertainment will have ample time to do so.

The guest of honor of the Congress is Dr. F. Howard Humphris of London, England. Dr. Humphris is an authority on physical therapy and his books and other contributions are well known and regarded in this country. This eminent physician will bring several important messages of scientific interest. He has promised also to take an active part in the discussions and his presence should lend much dignity to the occasion.

Fellows are urged make every effort to attend this gathering. They are urged also to prevail upon their colleagues to come. New York is a great medical center and postgraduate instruction is always an attraction to the progressive physician. After the

session of the Congress, a special short course in physical therapy will be given at the College of Physicians and Surgeons of Columbia University. This institution is in a position to offer a comprehensive course as the department has a qualified list of teachers who are on the medical faculty and in charge of the physical therapy departments in several New York hospitals. Those who are interested in this course should write to Dr. Norman E. Titus, 57 West 57th Street, New York City, who is director of the department of physical therapy at the Columbia University Medical School.

Every opportunity for clinics and clinical demonstrations will be given to those who are present at the meeting, the last day of which, Saturday, September 10th, has been set aside for this purpose. By referring to the program (see June issue of ARCHIVES) a list of the New York hospitals where clinics will be held may be noted.

Bring your family to New York if you so desire. New York is America's metropolis with a thousand and one places and things of interest. A committee on entertainment will do everything possible to make your stay as well as that of your family a most enjoyable one.

Come to New York and to the New Yorker! Make the eleventh annual session one long to be remembered!



THE STUDENT'S LIBRARY

RELATIVITY, An Interpretation of Einstein's Theory. By *Mario Palmieri*, B.Sc., M.E. Cloth. Pp. 87. Price, \$2.00. Los Angeles: Forbush Publishing Co., 1931.

Probably no other contribution to science has had wider publicity, been more often discussed and less understood than Einstein's Theory of Relativity. Clothed in its original form, in an armament of heaviest mathematical formulation, it was difficult for the intellectual world to pierce the kernel of its meaning without the aid of those exceptionally oriented in advanced mathematics. It has thus languished in respectable solitude and come to be accepted as the Caballa whose deciphering was limited to a half a dozen of super intellects only. Paradoxically, the glamour of this theory has now spread in every direction and has become synonymous with mystery and potentiality, whatever that may be.

"Relativity" is now rolled from tongues with a variety of nuances to take on as many meanings as the personalities of the people who glibly, lightly, seriously, pompously attempt to discuss its doctrines. Indeed, it has become the most classically misunderstood theory of modern times. The long felt need for an understandable interpreter and intelligent commentator has been answered by the publication of this work, written by one cognizant of the chaotic situation that has developed around this theory—one who has managed to present the facts without recourse to mathematical formulae or involved syllogisms. He has accomplished the impossible task of making The Theory of Relativity an easy and fascinating theory to read. The reduction of the doctrine to the, as it were, common intellectual denominator of the mass of people has been the purpose of the brilliant author. "This book is born," confesses the author, "from the desire to bridge the ever widening gap in the process of thought that is being formed between the great mass of mankind who cannot follow the progress of science and the small elite of the privileged few who, of this progress, are the main agents." It is his contention that unless something is done to humanize science, an undesirable situation will arise wherein a new autocracy will develop—an aristocracy of the intellect limited to the few. The book therefore is intended for average intellects, uninitiated in the mathematics of the problem.

The author has evaluated the entire doctrine from its historical position and scientific nature. The *a priori* position of Kant's absolute space is shown to be untenable in the light of Riemann's non-euclidean space relation. The unity or duality of space-time is demonstrated as an inseparable corollary and only the two together can present an independent reality. The relationship and the inter-influence of gravity on energy and mass, and the resulting curvature of space, is here presented in

such a clarifying manner that its limitation or finiteness is accepted with the same conviction as that of Euclidean space infinity. "It remained for Einstein," the author points out, "to show that it is vain to think of energy separate from matter.... With the theory of relativity gravitation assumes a new place in the order of nature, a secondary position where the attraction of masses is derived from the consideration of the physical changes induced in the universe as a whole by the existence of the masses.... It remained for Einstein to reject definitely the existence of the ether and assume that, regardless whether the ether exists or not, absolute velocity through space can never be detected by any type of experiment."

By a brilliant stroke of mathematical reasoning, Einstein, it is here shown, divorced obsolete reasoning regarding spatial-temporal relationship and prepared modern science for the revolutionary doctrines as enunciated by him, in 1905, "On the Electrodynamics of Moving Bodies." The final judgment as regards the value of Einstein's Theory of Relativity has according to the author, now had scientific confirmation and has been "proved by the concordance of its previsions with observed facts." The first proof was the successful demonstration of the peculiarity of movement of the perihelion of Mercury. The second was furnished by the behavior of light rays, which demonstrated the deflection of light rays when it crossed a gravitational field. The third proved that the state of movement effects the occurrence of phenomena in the physical world. Thus the spectral line of each element (observation made on the solar spectrum as compared with the earth) appears displaced toward the red, showing thus the effect of longer waves and slower vibrations.

The facts regarding "Relativity" have here been presented in a style that has the orderliness of the scientist and the brilliancy of one steeped in the lore of the doctrine. There is more than a passing bond between the theories of relativity and the discipline of physical therapy. Our interests are basically allied to all new interpretations of physical science. It is suggested that this volume be added to one's collateral reading as a part of the background that goes to make up the educated physician. It is a delightful and brilliant interpretation of a most difficult subject. The publisher is to be complimented on the *de luxe* makeup of this edition.

SURGERY OF THE CHEST. By *George F. Straub*, M.D., F.A.C.S. Cloth. Pp. 475, with 341 illustrations, including 68 color plates. Price, \$10.50. Springfield, Illinois and Baltimore, Maryland. Charles C. Thomas, 1932.

The author has in this concise treatise on chest surgery contributed a most practical and useful volume on that subject. The past twenty years have

seen the development of skill in surgery of the chest by an increasing number of surgeons devoted to this phase of practice. The author has evidently devoted some years to such surgery and gives not only a practical résumé of his own experience, but has here compiled the most important contributions by leaders in the subject. Particularly in his descriptions of the rationale of the operative procedure itself are his statements clear and direct. Nowhere can he be accused of being verbose. A majority of the illustrations have been done by the author and evidence considerable versatility. The illustrations depict with clarity conditions and procedures sometimes found difficult to explain in the text. H. L. Arnold has satisfactorily collaborated in contributing chapters on the physiology of respiration, the pathological physiology of the thorax, the use of x-ray in thoracic surgery and the therapeutic pneumothorax. This work assumes a place of importance for, and is recommended to, the surgeon engaged in, or about to extend his scope to chest surgery.

DIE ELEKTROCHIRURGIE. By *Prof. Dr. Franz Keysser*, Direktor Des Vinzenzkrankenhauses, Berlin. Paper. Pp. 238 with 252 illustrations in text and 6 colored plates. Price, 45.50 Marks. Leipzig: Fischer's Medizinische Buchhandlung. 1931.

This book possesses extraordinary qualities of scholarship, vision and orientation in electrosurgery. It touches supreme heights in this field and arouses an enthusiasm difficult to subdue the superlatives that clamor for expression. It is a rare contribution to modern surgery for it possesses that scholarly leverage which makes for progress by stimulating the conservative surgeon to adventure into the fields explored by the author. For want of a better description we borrow the trite expression that it is the "last word on the subject." Artistically, the book is well rounded out by the splendid mechanical collaboration of the publishers. The clear type, the luminous illustrations, and the generous size of its pages indicate unusual co-operation between printer, publisher and author.

The work is divided into two sections: General and Clinical. The first deals with the technical and theoretical side of Electrosurgery. The introductory chapters define and explain the various terms associated with this study, such as Electrotomy (Coagulation), Electrocoagulation, Carbonization, Fulguration; it distinguishes the difference between electrosurgery, diathermy and the nature of apparatus used. Broad but searching enquiry is directed into the nature and development of high frequency apparatus and its current, the effect of damped and undamped waves, the meaning of ultrahigh frequency waves as related to surgery. The two chapters on electrosurgical technic and its effect on the various tissues of the body are perhaps the clearest index of the author's complete orientation on the subject. The exposition is coherent, terse and rich in the theories, practice and analysis of the discipline.

The second half of the work is devoted to the exposition of its clinical practice. It deals with indications for electrosurgical application in benign and malignant conditions; in accessible tumors about the various locations of the body. An exhaustive

array of material is introduced to demonstrate the practicability of the method. The cases range from benign skin growths to inaccessible tumors in the body cavity, such as head, neck, chest and abdomen. The illustrations accompanying the various case reports materially add to the conviction that electrosurgery is an important adjuvant. One closes the last page with a feeling of deep gratitude for the painstaking labors recorded by Keysser. This book should be in possession of every progressive surgeon.

PULMONARY TUBERCULOSIS. By *Maurice Fishberg*, M.D., Chief of the Tuberculosis Service, Montefiore Hospital, New York City, and of its Country Sanatorium for Incipient Tuberculosis. Fourth Edition. Cloth. Two volumes. Pp. 1191 with 240 illustrations. Price, \$15.00. Philadelphia: Lea & Febiger, 1932.

With this fourth edition, the publishers have divided Fishberg's popular text on pulmonary tuberculosis into two volumes. This was made necessary by the addition of over 300 pages and over 100 new illustrations. The work continues to be a compilation of the most recent and authoritative contributions on the various phases of this subject. In the new material added, under bacteriology we find discussed the filterable, ultra-microscopic and non-acid fast types of tubercle bacilli. Predisposition, as engendered in economic and social conditions, is stressed. A brief discussion of infra-clavicular infiltrations and the prognostic significance of apical and sub-apical lesions is contrasted. Epituberculosis, tuberculous bacillema, chronic and healed miliary tuberculosis are described. The place of BCG in prophylaxis is also noted, as are the dietetic measures recently suggested by Gerson. The profusion of roentgenographic illustrations increase the value of this work considerably. The author's many years of experience are seen especially in those portions of the book dealing with clinical diagnosis and the home management of the patient. His recommendations as to climatology are very sane and readily adaptable to practice. While apparently he is not so conversant with the operative methods to obtain pulmonary compression, the information contained will give the practitioner a good general knowledge of that rapidly developing field. This work is recommended.

ERGEBNISSE DER GESAMTEN. TUBERKULOSEFORSCHUNG. HERAUSGEGEBEN VON. *H. Assman*, Königsberg i. Pr.; *H. Beitzke*, Graz; *H. Braeuning*, Hohenkrug-Stettin; *St. Engel*, Dortmund. Vol. IV. Paper. Pp. 494 with 197 illustrations. Price, RM 47. Leipzig: Georg Thieme, 1932.

The fourth volume of this most modern and excellent system on tuberculosis continues the high standards set by its predecessors. Eight monographs make up the contents of this book. Represented as collaborators with their special subjects of discussion are:

M. Arborelius, Solleftea—"Distribution of Tuberculosis in General Population."

H. Kalbfleisch, Graz—"Pathological Anatomy of Tuberculosis in the Aged."

J. E. Kayser-Peterson, Jena—"Clinical Features of Tuberculosis in the Aged."

G. Schroeder, Schomberg—"The Fundamentals of Specific and Non-Specific Chemo and Pharmacologic Therapy."

W. Kremer, Beelitz—"Oleothorax."

W. Luedke, Sulzhayn—"Intrapleural Pneumolysis."

K. Nussel, Waldesheim/Dusseldorf—"The Mechanism of Healing in Childhood Tuberculosis, as Shown Roentgenologically."

A. Beutel, Prag—"The Topography and Morphology of Pulmonary and Intra-Glandular Calcifications."

A most complete and detailed résumé is given of each of these various subjects, each with an exhaustive bibliography, especially of the work which has been done abroad. Arborelius shows in graphical form the distribution of tuberculous infection, as determined by tuberculin testing in the most prominent reports which have been made in the last decade. Schroeder covers tuberculin therapy very completely. He also discusses the values and dangers in the usage of the different chemicals introduced in the treatment of tuberculosis. Many praiseworthy statements could be given these valuable contributions. They are heartily recommended to every worker in the field of tuberculosis. The publisher's book work always excites our great admiration.

CLINICAL DIETETICS. A Textbook for Physicians, Students and Dietitians. By *Harry Gauss*, M.S., M.D., F.A.C.P., Instructor in Medicine, University of Colorado, School of Medicine. Assisted by *E. V. Gauss*, B.A., Formerly Assistant Dietitian, Presbyterian Hospital, Denver, Colorado. Cloth. Pp. 490. Illustrated. Price, \$8.00. St. Louis: C. V. Mosby Company, 1931.

Several new books on dietetics have appeared during the past few years. This is no doubt due to the fact that numerous changes have occurred in the science of nutrition. The authors emphasize that in the selection of the material for discussion, only those diets for which a rational basis exists, have been considered; empiric diets with a few exceptions have been disregarded. "The diets which are discussed, are given in three forms, whenever the subject matter permits of this plan. This plan contemplates the needs of three groups of persons: first, the diet is given in detailed, calculated form for the use of medical students and student dietitians; second, it is given as a week's menu for

the guidance of hospital dietitians; third, it is given in simplified language for the patient himself."

In the first few chapters one learns of the principles of diet and the properties of food. These subjects are treated in an interesting and comprehensive style. The classification of food, in outline, as it appears on page 64 is novel and valuable to the student. Few books deal with the subject of food as this one does. It at once shows an unusual perspective of a problem which has been heretofore handled too superficially. Digestion, the related problem has received adequate consideration.

After dealing with the normal and routine hospital diets, the authors consider the relationship of diets to certain conditions and diseases. First fever is discussed, then gastric and intestinal disorders, disorders of the colon and disorders of the liver and gall bladder.

Chapter XI deals with diabetes and Chapter XII, with obesity. Renal-vascular diseases and cardiac disorders are discussed in Chapters XIII and XIV respectively, while Chapter XV covers the subject of epilepsy.

The vitamin deficiency diseases as a modern subject has received no little attention from medical and lay standpoints. It is only natural that a new book on dietetics should review the material now available and submit it in rational form. This is well done by the authors in Chapter XVI.

Chapter XVII is given to gout and arthritis, and Chapter XVIII to food poisoning and allergy. The appendix is in tabular form giving the chemical composition of 100 gram edible portions of common foods, ash constituents of foods in percentage of the edible portion, and the vitamin content of some common foods.

The reviewer felt that a brief account of the contents of this book was essential to a portrayal of its wide scope. There are so many valuable features such as the specific diet lists, the calorie calculated diets, the methods of preparation of foods, and the principles upon which the various diets are based. Constipation as a colonic disorder is discussed. The treatment of the condition is described with special reference to dietary régime.

It is extremely difficult to enumerate the excellent qualities of this book in a short review. The subject matter has been carefully compiled, classified and presented in orderly sequence. The vast experience of the authors and their scholarly standards are manifested throughout the work. It is indeed far from an exaggeration to state that this is one of the best volumes on diet which has come off the press in recent years.



INTERNATIONAL ABSTRACTS

The Combined Trypaflavine Quartz-Light Treatment of Psoriasis Vulgaris — A Report of 111 Cases thus Treated. S. J. Zakon, M.D.
Ill. Med. Jour., 61:444, (May) 1932.

The author has made use of trypaflavine, a photosensitive dye in combination with ultraviolet radiation for the treatment of psoriasis vulgaris. The present report is the result of studies on 111 patients. Trypaflavine intravenously acts not only as an antiseptic *par excellence*, but it also influences hyperpigment formation on exposure to actinic rays, that is to say, on the affected areas and also on areas not in contact with the ultraviolet rays. The cases selected for study consisted of mixed types, acute, subacute and chronic. They were treated by intravenous administration of aqueous trypaflavine solution and by general body irradiation with the air-cooled quartz mercury lamp. Thirty-seven patients were healed by this treatment alone; "sixty were markedly improved, but at the end of the treatment some inveterate lesions remained that did not respond to this therapy." The average duration of treatment was 37.9 days. The average number of injections was 10.8 and the maximum number was 26. The strength of trypaflavine used at first was one per cent aqueous solution, but at present a 0.5 per cent aqueous solution is found effective. Of the complications, paravenous infiltration is perhaps the most serious and should be guarded against, other transient complications, as nausea, vomiting, headache and fever could always be controlled by stopping treatment. The technic is as follows: an injection of 5 cc. to 10 cc. aqueous trypaflavine 0.5 per cent is given intravenously 3 times a week and is followed within 15 minutes by daily, general body exposure at 40 inches for 20 seconds. The irradiation is gradually increased but must always be below the erythema dose. Daily lukewarm baths and the application of 5 per cent boric acid ointment to the lesions is recommended.

Some Observations on the Use of Electrolytic Therapy in the Treatment of Periapical Infection. Raymond Werther, D.D.S.

The Dental Cosmos, 74:328 (April) 1932.

The author's summary is as follows:

Using the number of treatments needed to obtain a negative culture as an admittedly imperfect but at present an indispensable criterion of the relative values of two methods of treating periapical infection — (1) camphorated monochlorophenol, topically applied, and (2) electrolytic therapy with a zinc iodidiodin solution — we reach the conclusion that the second method is preferable. Cases which had repeatedly given positive cultures (persistence of infection) rapidly gave negative cultures after the institution of electrolytic therapy. The preliminary topical treatment did not seem to contribute to the

rapidity with which these negative cultures were obtained. Certain cases, for which topical medication was strongly contra-indicated by past clinical experience, readily gave negative cultures when treated by electrolytic therapy.

Sufficient time has not yet elapsed to afford a systematic, roentgenographic follow-up of these cases. This is being done because we clearly recognize that the normality, completeness and rapidity of periapical bone regeneration are criterions of at least equal importance to the one we have employed in the preparation of this paper. Such roentgenographic evidence as we have on hand indicates that normal bone regeneration does occur in a satisfactory manner after electrolytic therapy.

Gonorrhoeal Complications — Diathermy. W. Frymann.

Medizinische Klinik, No. 38, 1931.

Prostatitis reacts particularly well to diathermy. In the first few days, all local therapy should be avoided. One should confine oneself to Pantopon cones, Papaverin, mild heliotherapy (irradiation of the perineum with the Landecker Lamp, or the like), balsamics, mild physics. On the third or fourth as well as on the sixth day, 10 c.c. Aolan should be given intramuscularly (milk or vaccines act less favorably). If there is no tendency to form abscesses, no spermatoecystitis or colliculitis, and when there is a striking change in the condition of the prostate lobes within a few days (careful control by palpation, suppositories, Ichthyol clysmas), one can begin using diathermy on the tenth to twelfth day, although at first not rectally, but with the perineum electrode. First dose about ten minutes, only slight feeling of warmth on the perineum. Sometimes, a slight fever reaction appears after the first treatment; the second should then be postponed for two or three days, and in the interval, rest, cones, etc. The fourth diathermy is the first to be given rectally, eight minutes, gentle warmth. Of the balsamics, Santal Midy is still, as before, unsurpassed; Pyridium Neoblennosan, possibly methylene blue, also have a good effect; when the urine begins to get clear, Neohexal, Uronovan, or the like. Careful massage of the prostate to empty out the remaining pus only after the disappearance of all complications, never before the eighth to tenth diathermy.

Spermatoecystitis should be treated at the same time as the prostatitis. It is one of the chief causes of the so-called relapses of prostate gonorrhoea. It is best to make use of a prostate electrode, which is carefully inserted by proper fixation on the opposite thigh in the direction of the affected side. At first, very weak currents; no massage because of the sensitivity. With induration of the seminal vesicle, energetic diathermy, but only after the complete healing of the gonorrhoea.

The colliculus almost always becomes diseased as a result of prostatitis, etc. Symptoms: spastic, cramp-like pressure on the perineum on urinating, increased desire to urinate, painful pollutions, itching and prickling, sometimes uninterrupted tenesmus, which can irradiate into the surroundings and up into the inguinal region, very haemorrhagic or haemorrhagic-purulent residual urine, or terminal haemorrhage without serious bladder or prostate findings. Therapy at first not local, only sedative; heliotherapy, and only after the abatement of the acute symptoms, very mild diathermy from the perineum out. Guyon instillations and bouginage are specially warned against in the acute stage.

Abscess formation in Cowper's gland can be treated only surgically. Epididymitis, on the contrary, is a grateful field for diathermy. The prostate and seminal vesicles are usually also more or less diseased at the same time. Here, too, at first Aolan, Terpichin, Caseosan, or the like, whereas vaccines (so excellent in gonorrhoeal arthritis) rather stimulate the process. After the disappearance of the acute symptoms (on Aolan in four to six days), begin the diathermy with the water electrode indicated by the author (*»Diatest«*, obtainable from the Elektr. Gesellschaft Sanitas, Berlin), a small porcelain or hard-rubber tub, over one edge of which a metal electrode dips into the liquid. The patient holds the tub, which is filled with about half a liter of a 5% NaCl solution, under his testicles, and himself regulates the depth to which they are submerged (not more than 2 to 3 c.c.). The wall on which the scrotum rests is lubricated to prevent the water from rising between the skin and the wall of the container. With 0.4 to 0.5 (maximum 0.7) ampere, a pleasant, regularly distributed warmth is experienced, since the possibility of a burn is excluded by the irregular action of the current. The indifferent electrode is a large lead plate fixed above the symphysis. In the subacute cases, six to eight treatments (two or three times a week) are sufficient in chronic cases, 10 to 18 treatments with currents up to 0.8 ampere.

With gonorrhoeal infiltrations of the anterior urethra, there should be introduced, about four weeks after the disappearance of all the other symptoms, an endoscope, whose tube is left in the urethra. The penis should be carefully wrapped around with a 3 to 4 cm. wide, thin metal electrode (thin Staniol is advisable for the underlayer—Ed.). Strength of current up to 0.6 ampere for 8 to 15 minutes. In drawing out the tube, care must be taken to avoid haemorrhages, since the mucous membrane fits itself closely around the endoscope. Massage according to *Dittel*, or the like, is not advisable. With strictures, bouginage up to Ch. 17/18, thereupon diathermy (exercising the most careful asepsis and control of the urine) by means of bougie and rectal electrode; at first, very slight currents in intervals of four to five days. — *Ars. Medici*.

Diathermy in Dentistry. Prof. H. J. Mamlok.

Therapie der Gegenwart, 8, 1931.

The following is the technique of sterilization of root canals with putrid contents: broad opening of the cavity and canal entrances, with use of the

coffer dam. After sterilization with alcohol and tincture of iodine, the cavity and the canals (the latter with a fine needle) are filled with hypochlorite. The inactive electrode is now placed in the patient's hand, whereas the active, a Miller needle, is introduced into the canal. The patient is told to lift his free hand just as soon as he feels any pain. A current of about 60 milliamperes is then turned on and the tip of the needle is moved back and forth in the upper third of the canal for two to three seconds (not longer!). To cool off the tooth, the current is then turned off for about eight to ten seconds even if the patient has felt nothing, and then allowed to act for two to three seconds on the middle third of the canal at a strength of 70 milliamperes. After a new intermission of eight to ten seconds, the needle electrode is pushed as deep into the canal as it will go without force and the current kept on till the patient begins to react. The current is then immediately turned off, the hypochlorite removed, the canals widened and refilled with hypochlorite, and the whole procedure repeated once or twice more, but with the addition of chloramine powder. Strict care should be taken to prevent the flow of liquid from the cavity to the gums while the current is turned on, because if this happens the current is diverted to the gums instead of going into the canal. The canals are then dried by means of sterile paper tips and then diathermy (50 milliamperes for one to two seconds). A compact filling should then be immediately inserted into the roots. There is usually no reaction whatsoever. The procedure must sometimes be repeated two or three times on the following day. If there was severe pain or a great deal of purulent flow from the root canal or a very putrid odor, only a temporary filling should be made. During the diathermy, the temperature in the root canal rises to 131 degrees F. and even higher; at 122 degrees F., all bacteria are destroyed. And in addition, the effectiveness of the hypochlorite plus the chloramine and of their gaseous derivative (chlorine in statu nascendi) is increased twenty fold under the influence of the heat.

An inflamed or exposed pulp can be removed after the introduction of arsenic pads or after anesthesia by injection. The pulp cavity is opened wide, the current allowed to act for one or two seconds (not longer, or the pulp will become boiled to pieces and crumbly!) at 60 milliamperes on the one or more canals. Repetition not before eight to ten seconds, otherwise danger of burns, even though the patient reports no pain! If there should be a burn on the gums, dab it with an 8 per cent zinc chloride solution; if there is a slight secretion from the root canal (rare), a sterile cotton or paper thread should be placed in the canal every second day and shut in by means of a Fletscher.—Inflamed tissue is so diathermized with two lead electrodes placed opposite each other that the patient experiences a slight warmth. The electrodes should not be removed till the current has been turned off.—In dental surgery, the current is increased to about 200 milliamperes. Then, with a fine wire snare, the tissue can be cut through without hemorrhage, as if with a sharp knife. — (*Ars. Medici*, Dec. 1931.)

Carcinoma of the Breast—A Critical Study of Twenty-five Cases. C. D. Lockwood.

West. Jour. Surg. Ob. and Gynec., 40:53 (February) 1932.

The author calls attention to the heavy mortality following surgical intervention. He also feels that roentgen therapy has fallen short of its expectancy. His personal experience is in agreement with those of other men who have either combined surgery with radium or radium alone. He prefers to use radium according to the method described by Handley, (*S. G. & O.*, 45:721, Dec., 1927) of London, who advocates the postoperative use of radium as a means of preventing recurrences in the glands which lie along the course of the internal mammary artery. Handley pointed out that "recurrences rarely takes place, after the radical operation, in the axillary glands and skin, but occurs in the supraclavicular and internal mammary glands before general dissemination. Since adopting routine radiation he has reduced his mortality by 25 per cent. The author states that he has essentially followed Handley's method but has used 12.5 milligram unscreened radium needles, leaving them in for 24 hours. This gives a total usage of 1200 milligram hours. He offers the following conclusions:

"In a critical review of 24 cases, 12 of which were treated by operation alone, and an equal number in which the postoperative radium was employed, I am convinced that the cases treated with radium have given distinctly better results. All cases were in the operable group, most of them with axillary involvement. There were none in the very early favorable group and none in the hopeless advanced group. All were proven carcinoma cases by microscopic examination. Of the 12 cases treated by radical operation, and, with the exception of two, by postoperative x-ray, only four lived more than three years; of these one lived five years, one four years and seven months and one lived seven years. All had recurrences. Of the twelve cases treated postoperatively with radium, seven are living and well three or more years after operation. In five of these, there have been no recurrences. One lived for five years without recurrence and then developed a recurrence in the manubrium after a severe blow upon the chest. One recurred in the axillary glands. These were removed by secondary operation and radium again applied to the axillary region. The patient is living three years after the original operation, with no recurrence since the second operation."

Radiothermic Treatment of General Paralysis. Hinsie and Carpenter.

Psychiat. Quat., 5:215, 1931.

The authors present a preliminary report of their findings in the radiothermic treatment of 17 cases of general paralysis. Eleven of these cases have left the hospital definitely improved, 5 are still in the hospital, having but recently completed their treatment, and 1 case is dead, having died shortly after the course of treatment started. The plan of ap-

proach was to produce the temperature curves of inoculated malaria in a series of patients with general paralysis. If these conditions were met, it was considered that there might then be more or less suitable control material by which the efficacy of radiothermic treatment might be computed. All patients were adults. Each was given treatment consisting of 70 hours of temperature. They noted the following facts: (1) The treatment was tolerated well; (2) the agent that induces the temperature rise is under immediate control; (3) the temperature rise may be gauged to meet the cardio-vascular-nephritic capacity of the patient; (4) the patients usually show improvement while they are undergoing treatment; (5) there is a loss of 5 to 10 pounds of weight, which is promptly regained upon termination of the treatment; (6) there is a mild anemia, a reduction of hemoglobin, an increase of the polymorphonuclear cells, and the spinal cell count is reduced during the treatment—all swinging within normal limits upon termination of the treatments; (7) the blood solids and chlorids all remain within normal limits during the therapy; (8) the blood sugar tends to rise slightly during the radiothermic course. Concerning the Wassermann findings in the blood and spinal fluid, the authors make no note—stating that it is too early to form any opinion as yet, concerning this phase of their work—*Am. Jour. Med. Sc.*, (Feb.) 1932.

The Treatment of Cancer of the Lip by Electrocoagulation and Irradiation. G. E. Pfahler and J. H. Vastine.

Journ. A. M. A., 98:32, Jan. 2, 1932.

The paper is a review of 253 cases covering a period from 1902 to 1930 inclusive. Nearly all these cases occurred on the lower lip and in smokers, and repeated small traumatism is encountered in most of the histories. The two main forms are described: the papillary form, which is slow growing, and invades the deeper tissues and lymph nodes relatively late; and the ulcerating infiltrating type, which metastasizes early. Early in the disease the two types are nearly alike and it is in this stage that treatment should be instituted. The public should be taught that when one notices a change on the lip indicated by crusts, scales, fissures, "fever blisters," or a warty growth that does not heal within two weeks his physician should be consulted. There should be no deaths from cancer of the lip.

Of recent years the authors do routine biopsies for scientific records, but treat all suspicious cases at once without waiting the result of microscopic examination. The technic of electrocoagulation is described, and following this x-ray therapy is given over the lip and chin, and in the submental and submaxillary regions. In some cases radium also was used.

The results obtained are quite remarkable. In all primary cases, even when there were palpable lymph nodes, there has been 95.5 per cent of recoveries. In recurrent cases 71 per cent have recovered. Of all cases (179) that were treated more than five years ago, 85.5 per cent have recovered.

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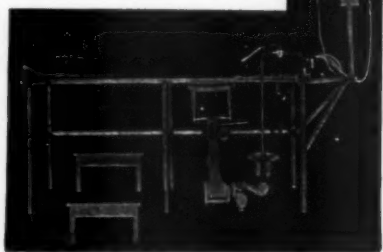
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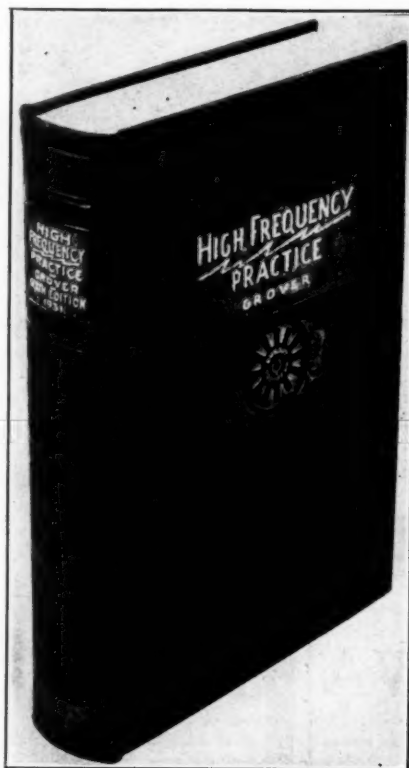
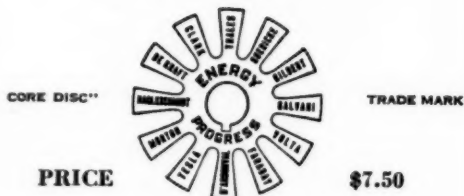
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